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Publishers
Temple Media Ltd
PO Box 9688, Blackrock, Co. Dublin, Ireland
t +353 (0)1 210 7513 | **t** +353 (0)1 210 7512
e info@passivehouseplus.ie
www.passivehouseplus.co.uk



Editor
Jeff Colley
jeff@passivehouseplus.ie



Deputy Editor
Lenny Antonelli
lenny@passivehouseplus.ie



Reporter
John Hearne
john@passivehouseplus.ie



Reporter
Kate de Selincourt
kate@passivehouseplus.ie



Reporter
John Cradden
cradden@passivehouseplus.ie



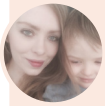
UK Sales
Stephen Molyneux
stephen@passivehouseplus.co.uk



Reader Reponse / IT
Dudley Colley
dudley@passivehouseplus.ie



Accounts
Oisin Hart
oisin@passivehouseplus.ie



Art Director
Lauren Colley
lauren@passivehouseplus.ie

Design
Aoife O'Hara
aoife@evekudesign.com | evekudesign.com

Contributors
Pat Barry, Irish Green Building Council | Ian Mawditt, Four Walls | Michael McCarthy, MMC Quantity Surveyors | Simon McGuinness, Simon McGuinness Architects | Marc O'Riain, doctor of architecture | Peter Rickaby, Rickaby Thompson Associates | Ekaterina Tikhoniouk, journalist | David W Smith, journalist | Jason Walsh, journalist

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ZEB Multi Comfort House, Larvik, Norway
Photo by Paal Andre Schwital/Brødrene Dahl

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editor's letter

ISSUE 23

Out of the frying pan and into the … wind tunnel? My Australian mother-in-law and her Irish partner recently decided to sell their home in the suburbs of Sydney to move to the top of a windy hill in Ireland, and retire *from* rather than to the sun. I don't blame them. September, their last month in Sydney, was a scorcher: it was the driest start to spring observed in Sydney since observations began in 1858, with numerous temperature records being broken across New South Wales. But it gets worse. Even if we manage to restrict global temperature increases to 2C above pre-industrial levels – and the global average last year was circa 1.2 to 1.3C of the way there already – a recent study indicates that temperature peaks of 50C are likely in Sydney by 2040.

If my mother-in-law thought she'd get some respite in Ireland, she was in for a rude awakening. Within a week of her arrival, Hurricane Ophelia came calling. Writing in the Irish Times in Ophelia's immediate aftermath, Prof John Sweeney, Ireland's pre-eminent climate scientist, paints a grim picture: "Over the past four years Ireland has experienced the wettest winter on record over most of the country, the stormiest winter of the past 147 years, and now its first taste of a near-intact Atlantic hurricane. For most Irish people, the question has been: is this the shape of things to come?"

Scariest of all, we risk being dangerously myopic if our only environmental concern is climate change. The mounting evidence is there, and it is frightening. At the current pace, there will be more plastic than fish in the sea by 2050. A global study has found that 83% of drinking water samples from around the world contained microplastics – which may harbour harmful pathogens and chemicals. Three quarters of flying insects in German nature reserves have vanished in 25 years – indicating potentially devastating consequences for the functioning of eco systems, agriculture and with it, human life. Poor air quality led to an estimated 428,000 premature deaths in Europe in 2014. I could go on – and that's without getting into housing crises, widening inequality, and the rise of populism in politics.

But as serious as the situation is, we must not despair. There is a common thread to the manifold threats that we face: unsustainability. The beauty of sustainable development, if we can somehow learn to apply these principles to how we live our lives and replan our societies, is that it promises to tackle all of these problems. We must resist the urge to seek silver bullet cures that may solve any one particularly frightening problem – even and especially in the case of climate change. If we somehow managed to stop the worst of climate change while maintaining a business-as-usual approach, we'll be even less prepared for other threats which may prove equally devastating.

When we shifted our focus as publishers towards the passive house approach, it was because we felt that on the balance of evidence, it was the world's best bet for radically reducing energy use in buildings, and with it, greenhouse gas emissions. But it was also because it aimed to protect indoor air quality through proper ventilation, tackled fuel poverty and occupant comfort by making buildings warm – but not dangerously warm – and because its focus on a well-designed, robust building fabric should ensure the longevity of buildings, and with it, reduced environmental impacts. But make no mistake: even in the built environment alone, passive house is not enough. There are a litany of other issues – materials, biodiversity, water, waste, microgeneration, location, and more – that we must also address to ensure our industry plays its part in handing our children and grandchildren a chance at a decent life.

Regards,
The editor

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About
Passive House Plus is an official partner magazine of The Association for Environment Conscious Building, The International Passive House Assocation and The Passivhaus Trust.

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THE RISE OF PASSIVE ARCHITECTURE:



The dawn of solar energy

In this coming series of articles, Dr Marc Ó'Riain will examine the history of sustainable, low energy and passive architecture during the 20th century and before, and take a look at some classic eco-buildings.

The body of knowledge that we draw on today in passive architecture comes from some ancient, and some more relatively recent precedents.

For example, the Roman architect, engineer and author, Vitruvius, recognised, as far back as 27BC, the way the ancient Greeks orientated their buildings to avoid overheating in summer and to capture solar gain from the low winter sun. Writing in the 5th book of 'De Architectura' (27BC), he recommended that designers should take "especial precaution that it be not exposed to the south; for when the sun fills the cavity of the theatre, the air confined in that compass being incapable of circulation, then is heated, and diminishes the moisture of the body". This clearly demonstrates an informed understanding of building physics and environment.

The Romans also used glass panes to accumulate heat inside a building from the low winter sun. So ubiquitous was this understanding of passive solar gain and orientation that the Romans passed laws to make "it a civil offense to block one's access to the south" Perlin (2000), perhaps the basis for England's 'ancient lights law' and the more recent Prescription Act of 1832.

The amassed knowledge of the Romans was passed down through master stonemasons and revived by the translation of Vitruvius' Ten Books on Architecture (De Architectura) by Cesariano in Italian in 1521, into French by Perrault (1673) and eventually into English by Shute in 1692.

These translations informed both a revival in classical orders and the education of the first academically qualified architects at l'École des Beaux Arts (1819). The lineage of environmental understanding in the discipline of architecture can be traced in an unbroken line to the Arts & Crafts movement.

Seminal exemplars like Broad Leys House (1898) embraced optimal orientation, with double height bay windows for light, a cantilevered balcony creating shading, the use of building fabric as thermal mass, placing service areas in the east of the house and having window sizes environmentally appropriate to room function. However, a disruptive paradigm shift in architectural practice in the 1920s would see the rejection of much of the amassed knowledge of building performance as architects embraced formal and compositional concerns.

Gropius & Meyer's Fagus Werks building (1911-13) broke with tradition with large unshaded thin curtain glazing, and brick and concrete fabrics acting as façade planes rather than supporting structures. The international movement and modernism would result in many environmentally dysfunctional buildings, many of them the exemplars of the paradigm.

The seed of a new interest in building energy performance can be traced to the contraction of Solar 1 at MIT in 1938/39. It would become the first building to be entirely heated year-round from solar energy. Boston businessman, Godfrey Cabot (1938), sponsored 50 years of research to convert "the energy of the sun to the use of man by mechanical, electrical, or chemical means". His proposal involved the use of flat plate sun collectors, with flat black metallic surfaces which would be covered by transparent insulators and heated by absorbing the sun's energy.

"To heat the building, a sun heat trap tilted at a 30-degree angle was placed on the roof under three layers of glass. The bottom of the box was fitted with a sheet of copper painted black, under which tubes ran. Water circulated through these tubes and then ran down into a metal tank located in the basement" (MIT 2017). "By the time Solar 1 was torn down in 1941… it had become clear that its heating system was effective but impractically expensive" (Levy 2017).

Over a sequence of test buildings, the engineers tested solar collectors on the roof, on the walls, in stacked black painted tin cans, using heat pumps, air circulating fans and various water storage configurations. Storage systems sometimes failed and once went on fire, and the second building lost heat dramatically through its fabric at night. Much like many active renewable energy systems research projects later in the 20th century, this project was solely focused on active solar energy as a solution, ignoring the ramifications of passive interventions for energy conservation in the building's design.

Oil prices fell after 1945, further undermining the economics of solar renewable research, but a small cohort of architects and engineers would continue to experiment with it through the 1950s and 60s. My next article will focus in more detail on the Dover Sun House of 1948. ■



The Tech

Oscar, Geiger Split On Outcome

Dormitory Board Votes Permanent Open House

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More 'Shmoos' Demand Obeyed

Occupants Of Unusual House To Be Warmed By Sun's Heat

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FIELD DAY SCHEDULE

(above) MIT student newspaper The Tech ran a story on Solar House II on 5 November 1946. Boston businessman Godfrey Cabot sponsored 50 years of research into solar power at the university.

Dr Marc Ó Riain is the president emeritus of the Institute of Designers in Ireland, a founding editor of Iterations design research journal and practice review, a former director of Irish Design 2015, a board member of the new Design Enterprise Skillsnet and has completed a PhD in low energy building retrofit, realising Ireland's first commercial NZEB retrofit in 2013.

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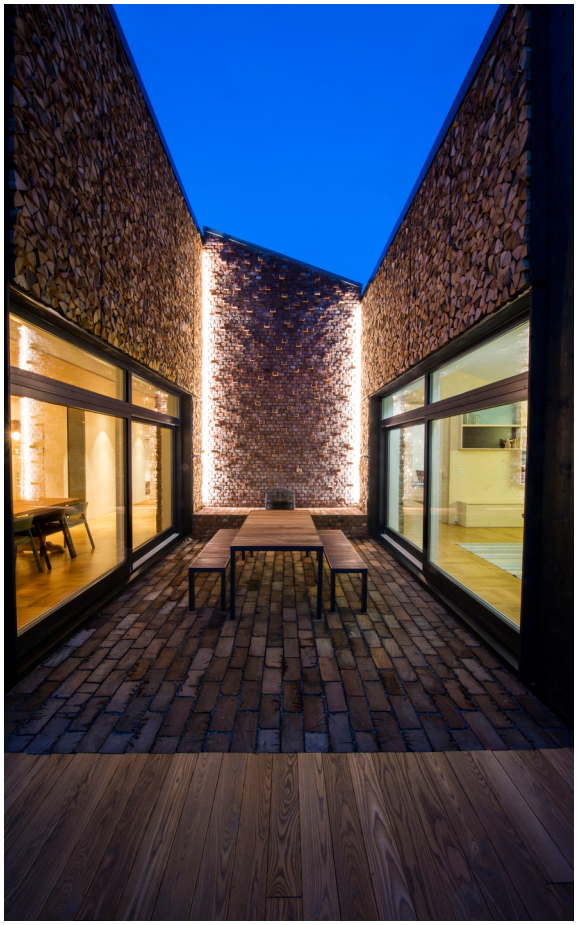
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ZEB MULTI-COMFORT HOUSE, LARVIK, NORWAY

This striking house in Larvik, on the south coast of Norway, was built to Saint-Gobain's 'Multi-Comfort' standard, a protocol developed by the global building materials giant that aims to deliver thermal comfort, low energy bills and indoor air quality, as well as visual and acoustic comfort. Multi-Comfort is based on passive house principles of a super-insulated, airtight and well-ventilated building envelope, but also emphasises factors like acoustic insulation and natural lighting.

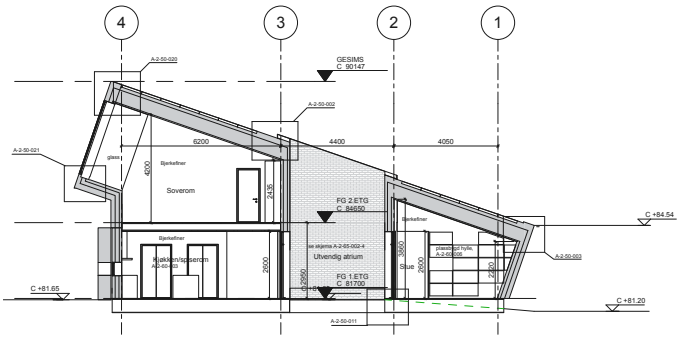
The 200 square metre house, part of a pilot project by Norway's Research Centre on Zero Emission Buildings (ZEB), is built with a glulam timber frame structure that's insulated with mineral wool and boasts passive-level airtightness of 0.6 air changes per hour.

Designed by globally renowned architecture practice Snøhetta, the house generates its own energy from various sources: heat recovery from wastewater that goes down drains, a combined Nilan heat pump and ventilation unit, hot water producing solar thermal panels, and a huge 150 square metre electricity generating solar PV array that covers most of the south-east facing slanted roof. The house is estimated to produce enough excess energy to power an electric car all year around, according to the architects.

Designed as a single family dwelling, the house serves as a demonstration unit for sustainable technologies at the Larvik facility of leading Norwegian heating and ventilation supplier Brødrene Dahl.

The ZEB Multi-Comfort House even has a swimming pool in the garden —which draws on the solar thermal system — plus a fire-heated sauna and outdoor courtyard for dining in summer. All of which sounds pretty luxurious for a house that manages to generate more energy than it uses.





Photos: Paal Andre Schwital/Brødrene Dahl











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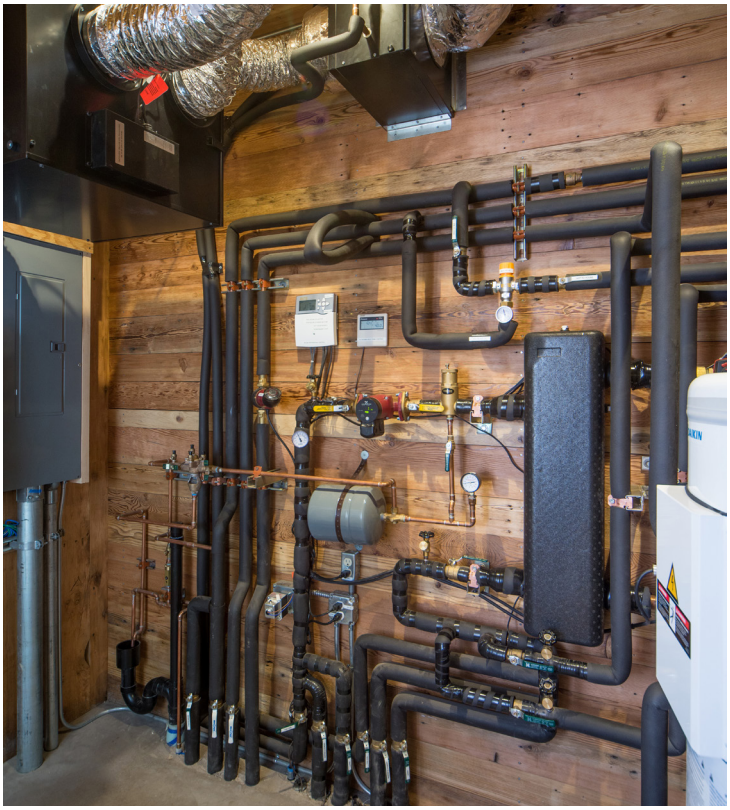
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DESERT RAIN, BEND, OREGON

Completed in 2015, Desert Rain is one of the few houses in the world that is certified by the Living Building Challenge, arguably the world's toughest green building standard. In order to meet the standard, buildings must meet rigorous criteria in seven categories: place, water, energy, health and happiness, materials, equity and beauty.

Prior to the construction of the house — which is located in Bend, Oregon —this urban site was home to two mill houses that were carefully deconstructed, with the vast majority of materials salvaged for re-use, much of it in the new dwelling. In total just one truckload of material from the deconstruction ended up going to landfill.

And the new house — designed by local sustainable architecture practice Tozer Design — naturally makes extensive use of ecological materials. Besides timber from the original mill dwellings, the team also incorporated salvaged wood from a barn in a nearby city, while any fresh lumber used was locally sourced and FSC-certified. Wood from a single walnut tree in nearby Portland was used for counter tops and cabinetry, and larch from a tree felled on site was used to make stair treads. The house also features clay-based plasters throughout.

To conserve water, rainwater harvested from the roof of the house is passed through a series of filters — including microfiltration and UV disinfection — to make it potable. Wastewater from sinks, showers and laundry machines is treated by an on-site constructed wetland system, while the house also features low water 'vacuum' toilets that are connected to a composting system.

Passive house aficionados will be happy too: Desert Rain boasts a super-insulated building fabric, with airtightness of 0.65 air changes per hour, triple glazed windows, and mechanical ventilation with heat recovery. And the house has three renewable energy systems: a 15kW solar PV array, a solar hot water system that contributes to both hot water demand and space heating (via underfloor pipes), and a solar hot air system that evaporates excess liquid from the composting toilet system.

"Desert Rain was designed to embody values that celebrate beauty, culture and spirit throughout," says the Living Future Institute, the organisation behind the Living Building Challenge. "From materials choices to landscaping and structural design, the team wanted to inspire a certain warm-hearted awareness and appreciation for their natural surroundings." ■

NEWS

Damp and mould can trigger first asthma attack, study finds

Researchers at the University of Otago, Wellington have shown that damp and mouldy homes can lead to the development of a first attack of asthma in young children, according to a major new study published in the journal Indoor Air.

"We have known for a long time that damp and mould will make asthma worse if you already have it but this is one of the first studies to show that mould may be actually be causing asthma to develop," says the study's lead author Dr Caroline Shorter from the department of medicine at UOW. "The study also found the more mould, the more cases of asthma."

The study investigated the homes of 150 children who had visited their GPs for their first prescribed asthma medication, and compared them to the homes of 300 matched children who had never wheezed.

"We found that mould and leaks were more likely to be found in the bedrooms and homes of children who had just started wheezing compared to the children who had never wheezed," said Dr Shorter.

"The amount of mould present in the bedroom made a difference: the more mould, the greater the risk that children would start wheezing."

Poor air quality killing 428,000 Europeans per year

Meanwhile, most people living in European cities are exposed to poor air quality, according to a new report by the European Environment Agency.

The EEA's 'Air quality in Europe — 2017 report' presents an updated analysis of air quality and its impacts, based on official data from more than 2,500 monitoring stations across Europe in 2015.

The data show that air quality in Europe is slowly improving, thanks to past and current policies and technological developments. However, high concentrations of air pollution still have significant impacts on Europeans' health, with particulate matter (PM), nitrogen dioxide (NO_2) and ground-level ozone (O_3) causing the biggest harm.

According to the report, PM2.5 concentrations were responsible for an estimated 428,000 premature deaths in 41 European countries in 2014, of which around 399,000 were in the EU-28. Poor air quality also has considerable economic impacts, increasing medical costs, reducing workers' productivity, and damaging soil, crops, forests, lakes and rivers. ■

Garway community centre set to meet passive house standard

The rural Herefordshire village of Garway is busy planning for a sustainable future with construction of a new community centre to the passive house standard. The project has taken many years of development, but a successful bid to the Big Lottery Fund in 2016 has finally made it a reality.

Currently two-thirds of the way through construction, the centre will provide many important functions for the village, including a large multi-functional hall with a full stage and green room, an outreach medical centre, a cafe/bar, and a part-time post office. It will also be home to 'Garway Live', a popular monthly local music event. The adjacent primary school will also use the centre for its school dinners.

The projects architects are leading passive house designers Simmonds Mills Architects and the contractors are William Powell & Sons of Hereford, who are working on their first passive house project, and who underwent training with the Passive House Academy in order to secure the tender.

Simmonds Mills have brought together their familiar team for the project, including services engineer Alan Clarke, structural engineer Bob Johnson and local quantity surveyors Adams Fletcher. The build is expected to be completed early next year.

As part of the passive house certification process, the first air test recently achieved a result of 0.22 air changes per hour.

Simmonds Mills have worked closely on the design with a strong community group, and the design of the new centre reflects characteristics of the former, much loved 80 year-old 'crinkly tin' village hall.

The new hall echoes the steep pitch of the old, and the inside of the building has a striking glulam arch frame. Exposed timber alludes to a traditional, natural feel, yet remains in keeping with a contemporary aesthetic.

The building utilises Knauf Insulation's Supafil Frame blown glass mineral wool insulation which was installed by accredited installer Miller Pattison. Externally, render and timber cladding were selected, and together with the galvanised steel roof the aesthetic pays reference to the rural context of the old hall and to traditional agricultural buildings. ■



(above) The building's glulam arch frame provides a striking architectural feature. Pictured are (l-r) main contractor William Powell & Sons MD Paul Quarrell; Simmonds Mills Architects directors Adele Mills and Andrew Simmonds; and Garway Village Hall Trust chairman Malcolm Howard.

England, Scotland & Wales will fail to meet 'nZEB' deadlines

London encouraged to adopt its own building energy standard

Words by Kate de Selincourt

An expert team working with the government's advisors on climate action has said there is "no feasibility in practical terms" of the UK complying with the near zero energy buildings (nZEB) target in the European energy performance of buildings directive (EPBD), when it kicks in in 2019.

The EU directive requires member states to make all new public buildings near zero energy by the end of 2018, with all new buildings following by the end of 2020. As many of the public buildings due to be occupied in early 2019 onwards are already being procured, information about compliance should have been available by now – but it is not.

The UK government is not expecting to know whether current regulations are compliant or require improvement before next spring, and any updating of Part L of the building regulations will now await the report of the post-Grenfell Hackitt Review of building regulations.

Professor Janette Webb of the University of Edinburgh, who leads the Climate Change Committee's heat and energy efficiency advisory group, told Passive House Plus: "In practical terms, there is no feasibility that we will comply, given that we are already in autumn 2017 and would have needed the policy in place well before now."

As indicated in Passive House Plus earlier in the year, rather than improving the energy performance of buildings, the government's emphasis as regards complying with the EPBD is focused on demonstrating the "cost optimality" of the current 2013 Part L. However even that assessment is not due until spring 2018.

The Department of Communities & Local Government (DCLG) told this magazine: "We have started work on the assessment as to whether current standards in building regulations across the UK meet 'cost optimal' levels as required under the EPBD – cost optimal being the level of energy performance that leads to the lowest cost over the life-time of a new building or improvements to an existing building.

"The report is due to be reported to the European Commission by 31 March 2018."

Meanwhile the UK government will not start consulting on possible improvements to Part L until the spring or summer of 2018, and even then will only consider improvements they deem to be "cost-effective and affordable".

"The independent review of Building Regulations and fire safety, being led by Dame Judith Hackitt … will report in spring 2018. Subject to its conclusions, the Government intends to consult on improving energy performance requirements for new homes, new non-domestic buildings and works to existing buildings where the evidence suggests that there are cost effective and affordable opportunities and it is safe and practical to do so," the DCLG said.

Although Scotland and Wales have committed to meeting the nZEB standard and to updating their devolved building energy standards as necessary, progress in these nations does not appear to be rapid enough to deliver compliance by early 2019 either. The Scottish government is planning a review of energy standards in light of nZEB requirements, but a spokesperson confirmed that this is only in its preparatory stage.

Meanwhile the Welsh Assembly has also pledged to review its building regulations, but a spokesperson confirmed that this is only in its "initial scoping phase".

Like England, the Welsh government appears to be falling back on a favourable interpretation of the current regulations in order to comply, at least as a stopgap: "We believe that improvements … made in 2014 will be found to achieve or have made a significant step towards the directive target." Passive House Plus was told.

> "An efficient building fabric drastically reduces energy consumption, makes the building more resilient.

Report urges London to adopt a proper energy metric

Meanwhile, a group supported by a wide range of construction sector organisations is urging the Greater London Authority (GLA) to make a clear commitment to fabric energy performance and set energy targets, updating the current "zero carbon" target to be more closely compliant with the nZEB target.

The GLA told Passive House Plus earlier in the year that that while it does not currently set targets for reducing energy demand, "we will consider developing one in the future".

In its report Getting to Zero, the London Energy Transition Initiative (LETI) calls on the GLA to put in place a metric "that is clear, simple to understand and readily comparable between buildings".

The report, endorsed by the UK Green Building Council, the Good Homes Alliance and many leading London design and engineering practices, proposes that in line with building performance standards used internationally, including by passive house, London should switch to a total energy consumption kWh/m^2 (energy use) metric including both regulated and unregulated energy, to replace the current CO_2 emission compliance methodology.

Also in line with the nZEB targets, the LETI proposals urge a fabric first policy with an efficiency target that takes into consideration both heating and cooling. Including (unregulated) cooling demand in the target would increase the pressure on designers to take account of, and minimise the risk of, overheating, which is a looming issue in London in particular.

"An efficient building fabric drastically reduces energy consumption, makes the building more resilient to weather extremes and decreases capital and maintenance expenditures on active building services.

"The risk of 'locked-in' inefficiency in the building fabric is more acute than that of building services – getting it right the first time is much less challenging than a 'fix it later' approach," the report team wrote.

The report also challenges the assumptions about carbon savings that underlie the requirement in the London Plan to connect to district/communal heating, and to gas CHP in particular.

"Currently, developments are typically obliged to utilise a district (communal) heating solution on site and/or connect to a district heating system where one is available … regardless of the efficiency of the district heating system of whether or not connecting to the system will actually achieve a reduction in carbon emissions, compared with alternative on-site solutions.

"This is acting as a positive disincentive for project innovations focussed on next-step reductions in thermal demand and developments that want to achieve zero combustion fossil free fuel on site," the report warns. ■






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World nZEB Forum takes place in Wexford this November



Photo credits: Mary Browne / Henry J Lyons / Field Condition / Gabari

Taoiseach Leo Varadkar has officially announced the first ever World nZEB Forum, which will offer delegates the chance to learn from world-leaders in low energy building.

Pre-forum workshops about nearly zero energy building on 15 November will be followed by the main conference at Clayton Whites Hotel in Wexford, Ireland on 16 November.

The Taoiseach joined event organisers from nZEBRA, theNearly Zero Energy Buildings Resource Agency, and representatives of the main event sponsors, Quinn Building Products, in government buildings on Wednesday 27 September to officially announce the forum, which is expected to attract hundreds of architects and construction professionals.

Over ten case study exemplary buildings will be presented at the event, involving commercial as well as residential projects, both new-build and retrofit. The forum will also hear from top government officials on the policy and regulatory framework and get a glimpse into what the future holds in terms of smart grid and sustainable communities.

On the day before the conference, 15 November, there will be a series of workshops held across three streams: hands-on practical lessons in nZEB quality control; a walk through of thermal bridge assessment & building energy modelling; and heating, cooling, ventilation and costing in high performance buildings.

The following morning, the main forum will feature three streams: on public sector nZEBs, 'high buildings with low emissions', and 'deep undercover: grasping the retrofit nettle'.

Meanwhile the afternoon will feature sessions on 'what is nZEB and how do we get there', 'kick-starting industry decarbonisation' and 'supply zone: renewable energy and smart girds'.

The closing plenary session will include three discussions. The first is on 'how we're going to fix the planet', and includes Prof James Freihaut, professor of architectural engineering at Penn State University and Prof J Owen Lewis, former head of SEAI and a committee member of the International Energy Agency.

Co-founder of nZEBRA Tomás O'Leary will then speak on 'essential issues facing the design and construction community in delivering nZEBs, before a series of speakers, including the United Nations Economic Commission for Europe's sustainable energy division director Scott Foster and leading Brussels architect Sabine Leribaux will offer their top takeaways on meeting the nZEB challenge.

Book now for a free Passive House Plus subscription

Tickets to the World nZEB Forum are priced at €285, and €255 for discounted tickets for members of various professional associations. A free annual subscription to Passive House Plus – worth €25 – is available to all Ireland or UK-based delegates, with a free digital subscription for international delegates. Current Passive House Plus subscribers will receive an additional year's subscription once their current subscription expires.

To avail of this incentive visit **www.nzebra.ie** and use the code PHPLUS when booking. ■

(above, clockwise from top left) The event will include presentations on cutting edge low energy buildings such as the Henry J Lyons-designed Central Bank of Ireland; Handel Architects' 26 storey passive house tower for Cornell University, New York City; Taoiseach Leo Varadkar pictured in government buildings launching the World nZEB Forum; and architectesassoc.'s deep retrofit of Leopold Tower, Geneva.



Secrecy of fire tests undermines public safety, Grenfell Enquiry hears

Words by Kate de Selincourt

The commercial secrecy surrounding the fire-testing of construction materials undermines fire protection by potentially obscuring serious concerns, a major alliance of fire bodies has told the public enquiry into the Grenfell disaster.

In its recommendations for the terms of reference of the Grenfell Enquiry, the Fire Sector Federation, a broad alliance of fire and rescue organisations, fire protection companies, building control bodies and product manufacturers, said: "the outcomes of product testing building materials is commercially sensitive... and as a consequence is never available in a raw state publicly" thus "weakening the UK's ability to identify serious concerns and undermining national protection."

This echoed comments by the chair of the Local Government Association, Lord Porter, in July: "If the public are going to have faith in this fire safety testing process then everything needs to be out in the open. It is no time for contractors or manufacturers to withhold test results from both councils and the public."

This call for disclosure of all past results has been endorsed by the NHBC, one of the country's biggest building control and certification bodies. While recognising that the cost of testing is borne solely by the company or organisation that procures it, the NHBC told Passive House Plus: "We believe the situation we are in is unique, and a list of all tests that have been carried out and a summary of their results, successful or otherwise, would be highly valuable to the industry. "

This magazine has so far been unable to obtain information about whether cladding systems failed large scale fire tests prior to the testing commissioned by the Department of Communities & Local Government (DCLG) this summer following the Grenfell disaster (see boxout).

It would appear that, at present, there is no clear mechanism for any fire expert undertaking a 'desktop assessment' of a cladding system's fire safety to check if the assembly previously failed a large-scale fire test. This leaves open the question of whether it is possible that cladding assemblies that failed a BS 8414 large-scale physical test prior to June 2017 subsequently 'passed 'desktop assessments. BS8414 is the British standard for testing the fire safety of external cladding systems.

So called 'desktop assessments' (or option three assessments) — in which the safety of an assembly was assessed by experts based on existing data rather than a physical test —were endorsed by the Building Control Alliance, the NHBC and a number of manufacturers as an alternative to the BS 8414 large-scale fire test, on the grounds that there were too many possible cladding component combinations for all to receive physical testing.

And if no large-scale tests were undertaken prior to this summer on assemblies that subsequently failed the DCLG's post-Grenfell testing, questions remain about why these systems may have been selected for desktop assessment rather than physical testing.

In August DCLG asked the BRE to publish the results of previous large scale fire tests on insulation and cladding "to help inform building owners' decisions about whether remedial work is required, and if so what materials could be used as replacements". Some test results have now been published on the BRE website.

However, all the results published at the time of going to press (30 in total) were of assemblies that had passed the test. All the rain screen assemblies included appear to have either a mineral-based insulation (stone wool), or, where the insulation was a PIR or phenolic foam, a mineral-based cladding (ceramic, mineral, fibre cement or 'mineral composite') system. None included the combination of aluminium composite material and foam insulation used at Grenfell.

Passive House Plus has seen a small number of other BS 8414 tests with pass results, but again these all contained one 'solid metal, mineral- or cement-based' element. However, some 'pass' desktop assessments seen by this magazine or other news organisations (such as the BBC) included foam insulation with ACM FR (aluminium composite material with a modified fire-retardant polyethylene filler) rain-screen panels, a combination which recently failed a BS 8414 fire test at BRE.

Sky News reported in mid-September that, "BRE has not responded to a series of questions including how many cladding systems failed the test and whether more than one fire test was carried out on any of the approved cladding systems in order for them to pass." Passive House Plus also has yet to receive a response from BRE to similar questions.

Exova, one of the main contractors offering desktop assessments, has told Passive House Plus that they are still carrying them out. "Clients are still requesting DTAs and we continue to carry these out in accordance with industry guidelines," a spokesperson said. "They are based on the data available at the time and issued on the understanding that they are subject to review if further data becomes available."

The UK government also appears to endorse desktop assessments, warning only that building owners using them to establish what type of assembly would be safe on high-rise buildings currently clad with ACM should ensure such assessments are "checked rigorously".

However the NHBC, which last year published guidance containing some "pre-approved" construction assemblies informed by a combination of fire tests and desktop assessments (including the combination of PIR and phenolic insulation with ACM rainscreen with a "Class B" fire rating) , has now withdrawn the guidance,

and will no longer accept such assessments as proof of compliance.

NHBC say that "in view of the latest knowledge provided by the Government tests, for ACM cladding in combination with certain types of insulation," they will only now accept as demonstrating compliance: the use of materials of limited combustibility for all elements of the cladding systems on buildings over 18m, or wall constructions that have been tested.

Experts question reliability of cladding fire test

However, experts including the Fire Brigades Union (FBU) and the Fire Protection Association have also questioned reliance on the BS 8414 fire test for tall buildings, although this is currently an accepted route to compliance set out in Approved Document B of the building regulations.

The Fire Protection Association (FPA) reportedly has concerns about the applicability of the standard BS8414 test to real life situations, and is intending to carrying out modified large-scale tests that they believe will more closely resemble conditions in a real building. According to a report in Inside Housing, the FPA will add windows and other fixings to the test walls.

"The FPA believes this is necessary because holes needed for screws and nails can cause fire safety issues, and the materials used to make windows can assist a fire to spread or enter the inside of a building," the report says.

According to Dave Sibert, National Fire Safety Advisor of the FBU, immediately after the Grenfell Tower fire the union suggested that there should be an emergency addendum issued to Approved Document B, that would put a freeze on the use of any combustible materials on high rise buildings without sprinklers – regardless of whether the assembly had been passed by a BS8414 of test or a desktop study. They wanted this freeze to stay in place at least until all the investigations into Grenfell were complete – though "the FBU hope it would not be lifted".

As Dave Sibert pointed out to Passive House Plus: "Scottish technical standards already demand that only non-combustible materials should be incorporated into a cladding system for a high rise building. It is disappointing that no such action has been recommended by the government's 'expert panel'."

Sibert was dismayed to learn that desktop assessments were still being sought: "It is even more disappointing to learn that the most dubious route to compliance with the building regulations is still being followed by some in the supply chain."

He concluded: "If no action is taken, the status quo will remain until Dame Judith Hackitt recommends a review of Approved Document B, and that review is completed, at least 12 months from today, if not much longer."

Meanwhile the public enquiry being led by retired judge Sir Martin Moore-Bick opened in September. The chairman has the power to compel the production of documents and to summon witnesses to give evidence on oath.

The Metropolitan Police are also investigating the role of over 300 companies or organisations, and "keeping an open mind" on the possibilities of pursuing both corporate and individual manslaughter charges, as well as charges relating to fraud, misconduct, health and safety breaches, and breaches of fire safety regulations.

The police have so far identified 2,400 witnesses to talk to, and are undertaking "a forensic examination of the tower which includes photographing and documenting every room on every floor, paying particular attention to fire safety provisions such as fire doors, the standards of construction work, the routing of pipework and smoke extraction systems".

At the same time, Dame Judith Hackitt is also leading a review of the construction industry and its regulatory system, requesting evidence from the construction industry in particular, to establish what changes need to be made. ■

Seven cladding materials tested by BRE

Following the Grenfell Tower fire and the widespread concerns that the cladding system – and, in particular, the aluminium composite (ACM) panels containing unmodified polyethylene cores — had played a major part in the severity of the blaze, the Department of Communities & Local Government commissioned BRE to carry out a series of large-scale fire tests on a range of cladding system combinations.

The tests demonstrated that a combination of PIR insulation and unmodified-core ACM cladding , similar to that found on the larger part of Grenfell tower, failed the test, and failed it unequivocally, within just 7 minutes of the 30-minute test.

Several other cladding combinations were tested, with results as set out below:

The DCLG's conclusions were as follows:

1. ACM cladding with unmodified polyethylene filler presents a "significant fire hazard" on buildings over 18m with any form of insulation.
2. ACM cladding with fire retardant filler present a "notable fire hazard" on buildings over 18m when used with rigid polymer foam, on current evidence, but can be safe with non-combustible insulation given some obvious provisos about correct installation and maintenance, appropriate fire breaks, etc.
3. ACM cladding with A2 filler can be safe on buildings over 18m with either foam insulation or stone wool.

	PIR foam insulation: most combustible	**Phenolic foam insulation:** combustible, but slightly more fire resistant than PIR	**Mineral wool insulation:** fire resistant
ACM: PE core unmodified polyethylene filler	**X Failed test** - considered hazardous	**X Not tested** - but presumed to present a hazard, by interpolation, as the combinations with both PIR and non-combustible mineral wool failed	**X Failed test** - considered hazardous
ACM: FR core – modified fire retardant polyethylene filler	**X Failed test** - considered hazardous	**X Failed test** - considered hazardous	**Tested √** - can be used with care
ACM: A2 core – limited combustibility filler	**Tested √** - can be used with care	**√** can be used with care - not tested but deemed acceptable by interpolation	**Tested √** - can be used with care

WHY CONSTRUCTION CONTRACTS



must change in light of Grenfell

Design-and-build contracts have become increasingly common in construction, a trend that must be reversed in light of the Grenfell Tower fire if we are to deliver safe and high quality buildings, says quantity surveyor Michael McCarthy.

When the Grenfell Tower tragedy struck on 14 June, people around the world looked on in horror at the building ablaze on their TV screens.

In one of the wealthiest boroughs in one of the wealthiest countries in the world, at least 80 helpless residents died for the sake of a cost-cutting decision that saved a relatively small amount of money.

In a recent article in the Guardian (4 September 2017), the new head of the RIBA, Ben Derbyshire, identified one of the main weaknesses that led to the Grenfell Tower tragedy. Namely, the side-lining of the architect's role in the design process through the use of design-and-build (D&B) contracts, in which a main contractor is appointed to both design and construct the project, rather than an architect or engineer leading the design processes.

In such contracts, the lead contractor will often sub-contract design work to an architecture or engineering practice, but that firm may not have the same level of design control or involvement as in a contract where the design is controlled by the client.

The growth in the use of D&B contracts has often little to do with the design component that a contractor is to undertake and more to do with the transfer of risk. A key feature of D&B contacts is the substitution of one type of material for another, often cheaper, in a process commonly referred to as 'value engineering'.

Value engineering should be a process of finding cost savings by getting a building or elements of a building to provide the same functionality and quality for less cost. It should be carried out at design development stage in conjunction with all the stakeholders and the design team.

However, it has become corrupted to mean substituting one type of material for a cheaper one at a later stage of the design process. Value engineering, as we now know it, should never substitute a material for one of lower quality. This is simply changing the specification.

In the case of Grenfell, this was done by the project quantity surveyor at the behest of the client, Kensington & Chelsea Tenant Management Organisation (KCTMO). One crucial 'value engineering' decision made was the reduction in the cladding specification from fire resistant zinc cladding to aluminium cladding with a flammable core, saving £293,368 in the process (Robert Booth, the Guardian, 6 July 2017).

How design-and-build should work

When a D&B project goes to tender, there should be a detailed employer's requirements document, which is a performance specification a contractor is to achieve. How this is achieved is often left to the contractor. The design should typically be 30% to 50% developed, allowing the contractor to complete the design.

The instances where D&B should be used are when there is a pressing time schedule that does not allow for complete design development or in repeat generic design where there is a choice of systems. In reality, D&B is being used more widely than this, often because it is a convenient method of risk transfer.

Many D&B tenders often are 80% to 90% designed at tender stage. Up to tender stage, the design team is under the control of the client, so the contractor has to 'guess' at the un-designed portion. Only after tender is the design team 'novated' across to the contractor. In this instance, contractors have little influence on the design in reality. They have to assess the cost risk of the remaining 10-20% and allow for it in their tender. This leaves much of the remainder of design decisions to be mainly choice of product.

Because D&B tenders involve contractors producing their own bills of quantities (BOQs), it transfers the measurement and quantification risk to the contractor. It also allows contractors to make calculated risk assessments on delivery and methodology. The downside is that every contractor bidding for the project must now produce their own BOQ, adding considerably to overall costs of tendering for the industry. This loss of quantification control also leads to a reduction in budgetary control on the part of quantity surveyors, as the D&B contractor now produces and controls the quantification process.

Taking back control in the 5D BIM age

This need not be the case anymore. The advent of BIM and better cost management methods make it possible to allow architects and design teams to regain the control that they have lost due to D&B contracts.

'5D' is the prefix that denotes the use of BIM for cost management. It is an underused power house of information that can revolutionise cost management and consequently, quality control.

Combining 5D BIM with the 'New Rules of Measurement' (NRM), published by RICS, makes this even more powerful. The NRM suite is a far superior method of measurement than either the old SMM7 in the UK and ARM4 in Ireland. In fact, NRM is a whole life cycle cost management system that has benefit to asset operators far beyond completion date.

By using 5D BIM methodologies, QS practices can offer real time implications of design changes and help designers and clients to find the optimal balance of quality, size and cost. Forms of contract can be devised or amended in order to get the balance of cost, risk, quality and responsibility right.

For architects to take back control of the design and specification, there also needs to be control and certainty of costs. Cost and design control go hand in hand. In order to avoid the mistakes of the past, architects should regain their rightful place as the lead position on projects. To do that, methods of cost management, procurement and the appropriate allocation of risk in each circumstance must be reassessed.

D&B contracts have their place, but their current level of use, in my view, should be reconsidered. The full facts of what happened in the Grenfell Tower tragedy have yet to be concluded. What we do know is that greater design team control and autonomy on all aspects of projects will mitigate and prevent the kinds of decisions that led to this disaster.

By fully using the tools and methodologies that are now at our disposal in a collaborative way, everyone's need for safety, quality and viability can be met. ■

Michael McCarthy MRICS MSCSI is a quantity surveyor with MMC Quantity Surveyors (www.mmcqs.com), based in Cork, Ireland & is involved with projects in the UK & Ireland.



WHY WE NEED

$100 per barrel oil prices again

Charting the last forty years of progress — and regression — on building energy efficiency in the UK, Dr Peter Rickaby argues that in the Brexit age more expensive oil prices might be the only thing that heralds a return of sensible policy.

I spent the summer of 1977 visiting American architects and academics to discuss their work on energy efficient houses. I was working for Philip Steadman, my mentor and colleague for many years, researching the second edition of his book 'Energy Environment and Building', which had been a best-seller after the 1973 oil crisis.

It was those American architects and academics who conceived the strategy of reducing the heat loss of a house to a level that could almost be satisfied by solar and internal gains, recovering ventilation losses with MVHR, and satisfying the remaining demand with a heat pump. This idea travelled across the Atlantic and was refined by the Passive House Institute into the de facto European domestic NZEB standard. Forty years on, I haven't found a better strategy.

> The climate change challenge has not diminished, but most UK politicians seem too gutless, too feckless or too obsessed with Brexit to rise to it.

The 1980s were marked by the Open University energy research group's ground-breaking research into domestic energy efficiency, led by Jake Chapman in collaboration with Milton Keynes Development Corporation (MKDC). Experimental developments at New Bradwell, Pennylands, Linford and Two Mile Ash were monitored and evaluated. Christine Uglow at BRE developed the BREDEM model, which Jake Chapman turned into the Milton Keynes energy cost index, to support the Milton Keynes Energy World exhibition.

The 1990s were characterised by three seminal events. First, Jake Chapman convened a group of experts who spent five days together designing the National Home Energy Rating (NHER). The success of the NHER, its imposition as an energy standard by MKDC, and its subsequent dumbing-down by the government to create the Standard Assessment Procedure (SAP), led to the training of hundreds of NHER and SAP Assessors, and the assessment of thousands of homes.

The second seminal event was the establishment of the building research energy conservation support unit (Brescu), which delivered the government's housing energy efficiency best practice programme. Innovative designs and technologies were tested, monitored and evaluated, evidence-based good practice guides and case studies were published, and hundreds of seminars and workshops were presented. Knowledge and skills were disseminated across the industry.

Also in the 1990s, the government commissioned a ten-year programme of work on the national non-domestic building stock (NDBS) database. The project was a joint effort by the Open University, Sheffield Hallam University, Manchester University, BRE and Rickaby Thompson Associates, and the team spent years surveying buildings and collating data. The NDBS database was abandoned by the government but survives at the UCL Energy Institute, where it is a powerful research and policy support resource.

By the 2000s, we seemed to be making progress in persuading industry to rise to the challenge of climate change. Regulations were tightened and subsidies such as the feed-in-tariff and renewable heat incentive were introduced. The zero carbon standard for new homes was announced and the Zero Carbon Hub was set up.

I spent much of the decade writing or editing technical guidance about energy efficiency for the Energy Saving Trust, the RIBA, the Construction Products Association and the National Housing Federation, and later for the Institute for Sustainability and the National Housing Maintenance Forum. At the end of the decade the UK Green Building Council's seminal report on the existing housing stock paved the way for the immensely valuable Retrofit for the Future programme, and the Green Deal. The Centre of Refurbishment Excellence (Core) was established with EU money.

However, between 2010 and 2016, everything went wrong. The Green Deal failed. The FIT and RHI subsidies and the CERT/ECO budget were reduced. The zero carbon Standard and the 2016 Building Regulations update were abandoned. The Energy Efficiency Partnership for Homes, the Zero Carbon Hub, the Institute for Sustainability and Core disappeared, and almost the only worthwhile project left is the 'industry led' implementation of the 'Each Home Counts' review.

It is difficult not to blame UK politicians for this demise, especially when we look across the water and see Irish government ministers giving keynote speeches to launch well-funded energy programmes at retrofit conferences. The climate change challenge has not diminished, but most UK politicians seem too gutless, too feckless or too obsessed with Brexit to rise to it.

At an AECB conference a few years ago, energy consultant John Willoughby gave an entertaining talk on 'forty years of energy efficiency in housing', which showed that almost all UK energy activity during that period was driven by the international oil price. If so, let's bring back $100 per barrel. ■

Dr Peter Rickaby is an independent energy and sustainability consultant, a member of the 'Each Home Counts' implementation board, chair of the BSI retrofit standards task group and a trustee of the National Energy Foundation. The views expressed here are his own.

IS BUILDING LIFE CYCLE ASSESSMENT



about to become easy?

Establishing a building's overall sustainability ultimately means quantifying the impacts of the materials used to construct it. Up till now, that's been a laborious, time-consuming process. That might be about to change, explains Irish Green Building Council CEO Pat Barry.

Imagine you could carry out a full life cycle carbon footprint on a building by just drawing it. As you optimise the design, it automatically recalculates with a refresh button. At the same time it compares your design to best practice across Europe. It no longer takes weeks of inputting disperse information into spreadsheets. Through the optimisation of design you're learning about the impact of the choice of structural design and construction materials on the carbon footprint.

This dream is now becoming reality. Irish Green Building Council (IGBC) has been working on a business plan to take embodied carbon calculation out of the hallowed realms of academia and specialist consultancies, and bring it to the professional masses.

The embodied impacts of buildings are simply too important to be brushed under the carpet. A 2012 study by Dr Jamie Goggins of NUIG suggested that embodied carbon accounted for approximately 34% of regulated energy in an Irish semi-d. A 2012 study by embodied carbon experts Sturgis Associates suggested that for offices it could be as high as 45%.

As we move towards the nZEB standard, embodied carbon becomes an ever larger part of the overall life cycle carbon of a building. Our current approach is to add materials such as triple glazing and insulation with consequent increase in embodied carbon to reduce operational carbon emissions. The irony is that we don't know if the additional carbon emissions invested in construction may ever be repaid during the lifetime of the building. Theoretically in Ireland we are moving to a fully decarbonised electricity grid and fully electrified homes and buildings. We may be putting a massive upfront carbon down payment for a loan that may never be repaid. Can we afford to put huge chunks of emissions into the atmosphere without checking the credit-worthiness of the recipient?

There have been good reasons why embodied carbon has never been regulated. Firstly, it was complicated. Secondly, the European carbon emissions trading scheme (ETS) removes targets from national governments for emissions from major polluters – including construction product manufacturers. Embodied carbon emissions fall through the cracks as they're not counted in national targets. A civil servant has little incentive to expend time including it within building regulations as they'll get no thanks from their target-chasing bosses.

This is changing. There are European standards such as EN 15978 which set out how carbon life cycle assessment should be calculated. The commission has just released Level(s), the first Europe-wide sustainability reporting framework. LCA is at its core. This framework is expected to be the first EU step towards a sustainable performance of buildings directive similar to the Energy Performance of Buildings Directive which brought us BERs. Level(s) is a first step to get member states and their design professionals up to speed.

Most educated building professionals are aware of benchmarks for operational energy use. They can immediately quote the passive house targets or ream off the threshold levels within the BER. How many could tell you best practice annualised embodied carbon per year for a school? Can we get to this level of embodied carbon literacy?

IGBC has set out a plan to develop this literacy. Step one required the development of the data needed for calculation. To do this IGBC has now developed an Environmental Product Declaration programme. This will allow Irish manufacturers to create, verify and publish the environmental impacts of their construction products through an Irish programme. The first EPDs are expected to be published under the programme before Christmas.

But many manufacturers have already developed EPDs under international programmes. They can now make these visible by uploading to the new EPD Ireland platform, www.epdireland.org. Those who have already uploaded their EPD include Saint-Gobain, Forbo, Kingspan, Ecocem, Smet and Ecological Building Systems. We estimate there are already at least 400 - 500 EPDs available in Ireland across the full range of products. Most of these are for imported products and have published through programmes such as IBU in Germany or the BRE in the UK.

The next step is to aggregate all of this into a national environmental database which will include generic data for common materials where product-specific data is missing.

The final step is to get the developer and procurers to request and pay for calculation of embodied carbon. The measurement of the full carbon footprint of a building is called a life cycle assessment (LCA). This typically also includes calculation of other indicators such as potential ozone depletion, acidification and eutrophication. This had been an extremely time-consuming activity which accounts for the fact that nobody did it voluntarily in Ireland unless they were PhD students.

IGBC is offering a simple solution to the market rather than just promoting LCA. To enable this, IGBC has now teamed up with the leading Finnish LCA experts Bionova to allow building professionals to quickly calculate the embodied carbon in a building through their One Click LCA software. The web-based One Click LCA takes the legwork out of calculating a full LCA to EN 15978. This reduces the time to a matter of hours rather than weeks and is now more akin to working out a BER. It draws on established European construction product databases.

But it gets better: by using the One Click BIM plugin the software allows instantaneous calculation of embodied impacts at the touch of a button. This allows quick analysis using heat mapping of the most carbon intensive elements of the building to identify where the biggest impacts can be reduced.

It will allow the creation of benchmarks for embodied carbon for different building types. IGBC is now participating in the Carbon Heroes programme, which will create benchmarks based on anonymous data from 1000 projects located in Norway, Holland and Ireland. IGBC has included embodied carbon in the Home Performance Index and wants to develop robust benchmarks that guide designers towards better practice.

LCA calculation is alien to most Irish professionals so the aim is to get training and accredited courses into the market. Education providers in the universities and institutes of technology will be provided with free licenses for One Click LCA so that life cycle assessment can be integrated into undergraduate and post-graduate courses. The intention is to make life cycle carbon calculation part of the education process. Then we can start integrating it into every design office in the land. IGBC is currently offering one-day training in LCA. ■

For more on EPD Ireland visit: **www.epdireland.org** and for more on Carbon Heroes visit **https://www.oneclicklca.com/construction/carbonheroes**



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WORCESTER SCHOOL HALL IS

UK'S FIRST 'MULTI-COMFORT' BUILDING

This unique sports and drama hall, inspired by the architecture of local buildings, was built to a new standard that aims to ensure buildings deliver all round health and comfort to their users.

Words by John Cradden
Additional reporting by Lenny Antonelli



£74

annual estimate for space heating bill

Building: 430 sqm school sports and drama hall

Build method: Glulam timber frame

Location: Hawford, Worcester

Standard: Certified passive house & Saint-Gobain Multi-Comfort building

Completed: March 2016

Budget: £1.2m

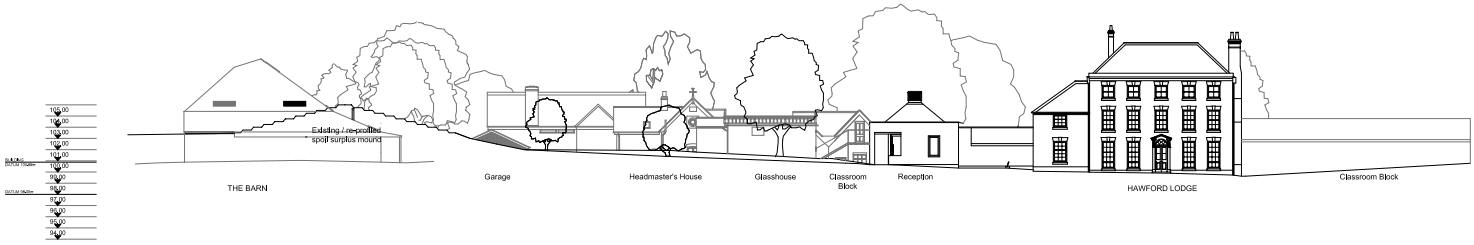




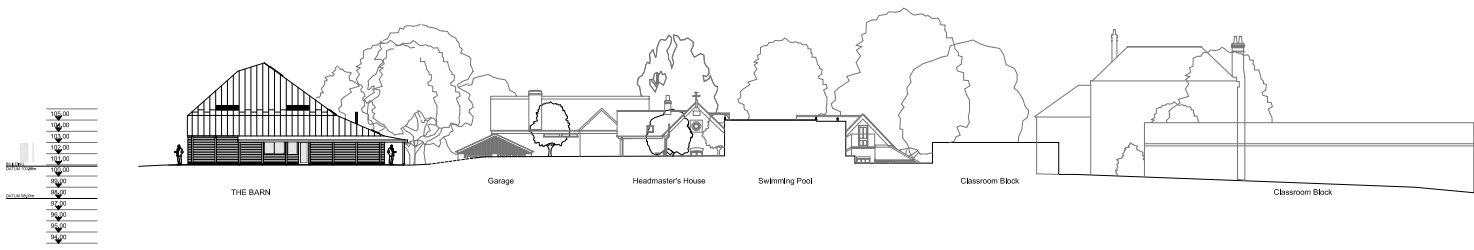
Proposed Site Plan Key 1:1250



Proposed Site Section A 1:200



Proposed Site Section B 1:200



Proposed Site Section C 1:200





A new school sports hall in Worcester is not only certified to the passive house standard, it's also the first building in the UK to meet building materials manufacturer Saint-Gobain's new 'Multi-Comfort' standard.

The Bartholomew Barn, a new £1.2m school building at King's Hawford, is a multi-purpose sports and drama hall that will be used for sports, assemblies, drama, music and dance.

John Christophers of Associated Architects, who had previously designed the school's distinctive new boathouse, advocated building the new facility to the passive house standard. But he also persuaded the school to make the project one of the first to adopt the Multi-Comfort standard.

Saint-Gobain's Multi-Comfort protocol is based on the fabric-first approach of the passive house standard, with its emphasis on solar gain, a highly airtight and insulated building fabric, and high quality ventilation. But it also adds factors like daylighting and acoustic comfort for a holistic approach focused on all-round occupant health and comfort.

"What we like about the Multi-Comfort standard is that it recognises sustainability is a complex multi-faceted concept," said Christophers. "Passive house as a standard is excellent on airtightness, thermal bridging, fabric-first etc., but says nothing about considerations such as acoustics, VOCs [volatile organic compounds], daylighting etc., all of which are included in Multi-Comfort."

The client was keen for Bartholomew Barn to fit in with the architectural character for the school's rural setting, which includes a listed Georgian farmhouse but also an 'eclectic' mix of historic buildings, many of which are timber framed. Choosing timber frame was an obvious choice because it is quick to construct while lending itself to achieving passive house levels of thermal bridge-free, highly airtight construction.

Another factor in its favour is that it is thermally lightweight, meaning it will respond to temperature changes more quickly. This, says Christophers, is important for a multi-purpose building that might need to be at 16C for active sports uses, and then rapidly heated to 21C for drama or a community event.

However, as a re-interpretation of an agricultural barn, it's a very striking one. The asymmetric roof form allows strong natural daylighting from north-facing rooflights running the length of the building, and also increased headroom for badminton and other sports, without needing to borrow any elements of what Christophers describes as the "ubiquitous blind brick-and-tin box form" of a sports hall.

The roof slides down at a series of gentle pitches to a covered loggia protecting the entrances, and supporting apple and pear espalier planting between its posts (Worcestershire is famous for its pears). Natural external materials include a standing-seam metal roof and untreated oak boarding help the building to sit comfortably within the landscape.

The form of the building itself provided the biggest challenge of the whole project by dint of "being a large volume, tall single-storey building, as the building's floor area and envelope parametrics are very different from a typical two or three-storey PHPP house, so the fabric has to work harder", said Christophers. Hence, it is heavily insulated, to

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> The big change for us was when we did our opening concert... the sound was absolutely fantastic within the building.

U-values under 0.1 for the walls, floors and roof.

To prevent overheating, and to avoid direct sun glare with badminton etc., the triple glazed rooflights, made by Fakro, face north. "They work well for those reasons although obviously they don't therefore contribute to useful winter heat gains," he said.

Users of the building are happy with it, particularly in comparison to the old school hall, which was known as the Cobb. Kevin Bethall, a teacher said: "The new building is in a completely different league altogether. It's light and it's airy. It's spacious and obviously the fact that it is temperature controlled also helps tremendously."

In terms of energy use during 2016, Cambridge Architectural Research — who are monitoring the building's performance in detail — estimate that it used 4 kWh/m2 for space heating over the year, taking real data from March to December and extrapolating to a full year. This is just 26% of the passive house target (15 kWh), although it was noted that 2016 was a particularly warm year and that the building typically operates at lower temperatures than the PHPP design standard of 20C.

The building currently runs on oil-fired central heating, but is shortly to be replaced by a central biomass boiler. Jim Turner, head of King's School, also says natural light in the building is excellent, and that the acoustics are superb.

"The big change for us was when we did our opening concert," he says. "It was quite clear that the performers were very comfortable within the building, the audience certainly was. The acoustics were such that, without a great deal of effort from the sound system, the sound was absolutely fantastic within the building."

"But also it was just extremely comfortable."







BARTHOLOMEW BARN: REAL WORLD PERFORMANCE

Since students and staff started using the Bartholomew Barn in March 2016, Cambridge Architectural Research (CAR) has carried out extensive research on the physical performance of the building.

As part of this research, CAR monitored both the performance of the Bartholomew Barn together with that of the old 'Cobb' building that previously housed the same functions, and which is still used by the school.

TEMPERATURE

During the second quarter of 2017 (April to June), the Barn maintained temperatures in the 18 to 22C range for around two-thirds of occupied hours, while the Cobb only managed this for 50% of the time — frequently going below 15C and above 25C (i.e. overheating).

During the last quarter of 2016 (Oct to Dec) and first quarter of 2017 (Jan to March) the Cobb dipped below 15C frequently during occupied hours, unlike the Barn, while not surprisingly the Cobb has been consistently colder throughout monitoring.

During one particularly warm week that began on 19 June 2017, when outdoor temperatures were frequently between 20 and 30C, and sometimes over 30C, temperatures in the Barn actually fluctuated more than the Cobb, and sometimes went over 25C and close to 30C. It was noted that the Barn was much more heavily occupied during this period, and monitoring showed temperature peaks in the Barn usually followed peaks in occupancy.

CO_2

The mechanical ventilation with heat recovery (MVHR) system in the Barn is designed to switch on when the CO_2 concentration goes over 800 parts per million (ppm). While there was a fault with the system at first, it has been operating correctly since January, and there has been an improvement in air quality since then.

Monitoring shows that during the second quarter of 2017, CO_2 concentration in the Cobb frequently went over 1,000ppm and sometimes up to 3,000ppm — presumably during periods of high occupancy — while in the Barn it very rarely went over 1,000ppm, indicating much superior indoor air quality.

HUMIDITY

For non-domestic properties, the Multi-Comfort standard requires relative humidity to remain in the range of 40-70%. Monitoring during 2017 has shown the Barn to be quite comfortably within this range almost all of the time, while the Cobb building is generally more humid, exceeding 70% humidity much more frequently.

WHAT DO THE TEACHERS THINK?

An anonymous survey of school staff at King's School by Cambridge Architectural Research has revealed that staff are generally very pleased with the comfort of the Barn — as contrasted to the old Cobb building, which is seen as dark and cold by comparison.

CAR said their preliminary research found two main negative issues among staff: the barn occasionally getting too cold in winter, and too hot when heavily occupied in summer.

To solve the former problem, it recommended investigating the function of the predictive algorithm of the underfloor heating, and checking if the heating system is programmed for weekend operation, and if external users are aware of how to control it properly. They also suggested that the use of carpet tiles for some events could be negating the effect of underfloor heating.

According to a survey of 11 staff members, most (eight and nine respectively) found indoor temperatures and air movement to be ideal in winter, but six found indoor temperatures to be too warm in summer. To deal with summer overheating, CAR recommended investigating whether there was a need for fixed shading, or more frequent use of the external blinds.

Speaking about this overheating issue, architect John Christophers told Passive House Plus: "This was an issue during the first summer, as the night time purging regime was not fully understood by all the users. The monitored results are therefore not as good as they should be. Since then the user controls have been slightly simplified, and further training and explanation given to the users as well. We hope therefore that we should have much better results next summer."

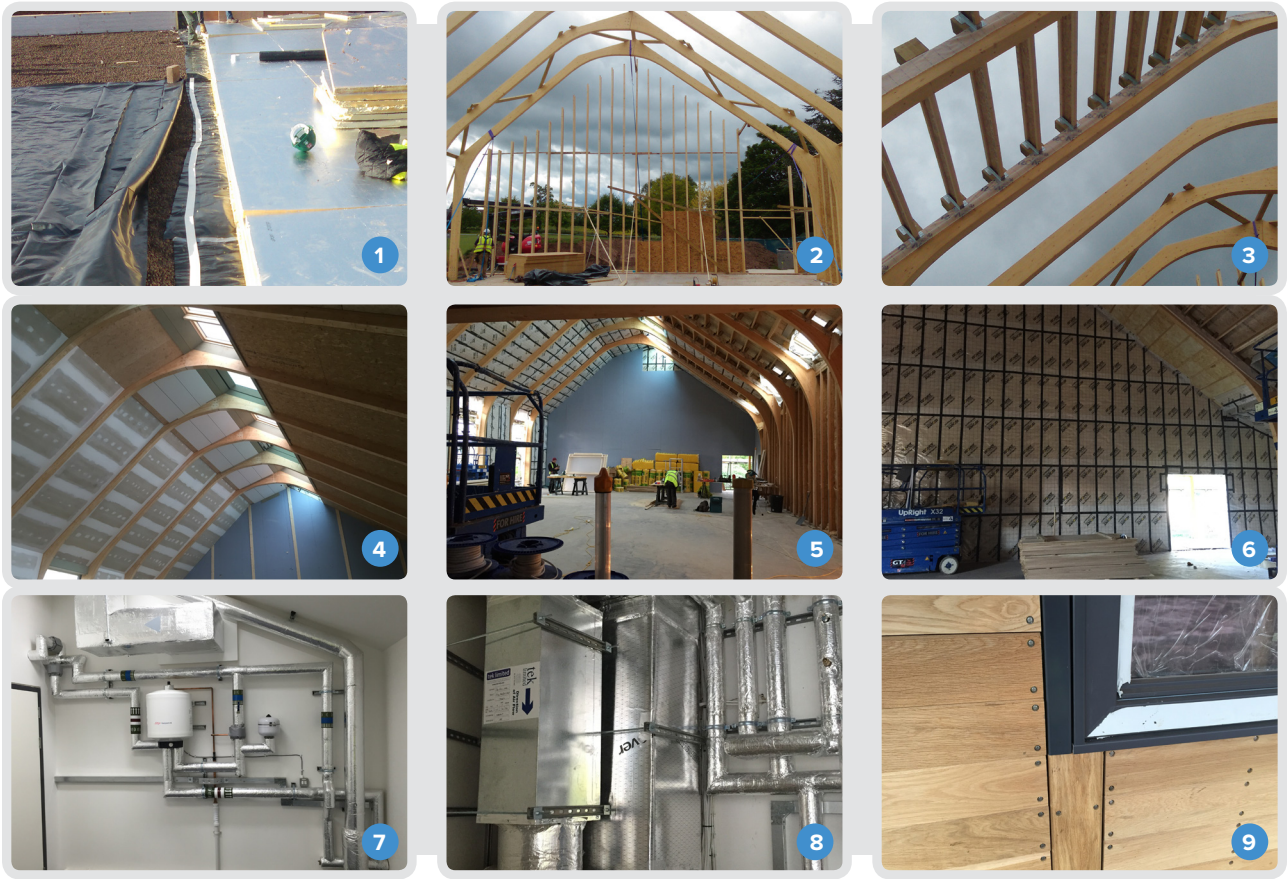
By Lenny Antonelli

Saint-Gobain Multi-Comfort standard for non-domestic buildings	
Space heating & cooling demand	15 kWh/m²/yr or 10 W/m²
Relative humidity	40 to 70%
Overheating	Limited to 10% of hours per year above 25C
Thermal bridging	≤0.01 W/mK
Daylight autonomy	60% of occupied time (08:00 to 18:00) a space is above daylight illuminance of 300 LUX
Acoustic sound insulation	+3 to 6dB of current regulation/guidance for building type
Acoustic absorption	Meets reverberation control regs for building type
Airtightness	0.6 air changes per hour
Ventilation	To be agreed with Passive House Institute based on review of planned occupancy patterns
Control of volatile organic compounds (VOCs)	Use of EN standard 16516 tested materials or internal material finishes that remove VOC concentration. Total VOC conc <150µg/m³ and formaldehyde level <100µg/m³

SELECTED PROJECT DETAILS

Client: The King's School Hawford
Architect: Associated Architects
M&E: Couch Perry Wilkes
Structural engineer: Shire Consulting
Passive house consultant: Future Komfort
Passive house certification: Warm
Main contractor: Speller Metcalfe
Timber frame: Pasquill
Wall insulation & airtightness products: Isover
Service cavity insulation: Rockwool
Foundation PIR insulation: Celotex
Foundation clay insulation: Leca
Acoustic panels: Ecophon
Windows & doors: Rehau, via Solar Windows
Openable roof windows: Fakro
Fixed roof windows: Glassolutions
Plasterboard: Gyproc
Flooring: Junckers Timber flooring

CONSTRUCTION IN PROGRESS



1 Celotex FR5000 insulation boards being fitted over the polyethylene DPM and 175mm Leca Insufil expanded clay insulation; **2** erection of the timber frame superstructure, the unique shape of which was inspired by the rich historical tradition of vernacular timber framed "cruck" buildings around Worcestershire; **3** installation of I-beams onto the roof timbers, with Isover Vario airtightness membrane in behind joist ends; **4** the asymmetric roof form allows natural daylighting from north-facing rooflights running the length of the building, and also increased height for sports; **5** & **6** the roof and wall build-up features Isover Timber Frame Batt 32 insulation with Isover Vario KM Duplex vapour control and airtightness membrane to the inside of this; **7** the Zip Varipoint instantaneous water heater with insulated pipework; **8** preinsulated ductwork for the Swegon heat recovery ventilation system; **9** Rehau triple-glazed windows installed flush with the external oak cladding, with the insulation layer sitting behind this.

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Ecology Building Society, 7 Belton Road, Silsden, Keighley, West Yorkshire BD20 0EE

IN DETAIL

Building type: 430 sqm multipurpose, timber frame school sports & drama hall (treated floor area: 391 sqm)

Location: The King's School Hawford, Hawford Lock Lane, Claines, Worcester

Completion date: March 2016

Budget: £1.2m (£2,650 per sqm)

Passive house certification: Certified

Space heating demand (PHPP): 10 kWh/m²/yr

Heat load (PHPP): 14 W/m²

Primary energy demand (PHPP): 115kWh/m²/yr

Heating costs (estimate): £74 per year, based on space heating demand of 4kWh/m²/yr as estimated by Cambridge Architectural Research for 2016, using monitored results from March to Oct. Also assuming boiler efficiency of 90% and oil price of 4.3p per kWh.

Overheating: 0.0% in PHPP (% of hours > 25C)

Adhered to BB101 design criteria for overheating: No more than 120 hours when the air temperature in the room rises above 28C; the average internal to external temperature difference should not exceed 5C; (i.e. the internal air temperature should be no more than 5C above the external air temperature on average); the internal air temperature when occupied should not exceed 32C.

Environmental assessment method: UK's first completed and certified Multi-Comfort building.

Airtightness (at 50 Pascals): 0.6 ACH

Energy performance certificate (EPC): B-32

Measured heating consumption: Taking measured heating and electricity consumption between March and December 2016 (10 months), and extrapolating to a full year using heating degree-days, Cambridge Architectural Research estimates the building to have had a space heating demand of 4 kWh/m²/yr during 2016.

Thermal bridging: Measures taken to reduce thermal bridging via detailed close scale construction drawings, and thermal bridge analysis (carried out by the PHPP consultant) at each critical junction: wall-roof connections detail, wall-slab connection detail, wall-roof connection plus window top detail, wall-wall connection (external corner), wall-slab connection and threshold, window connections, wall-roof connections: door tops and thresholds, fixed roof light connections, openable rooflight connections. All analysis was carried out to achieve thermal bridging Ψ value not exceed 0.01 W/mK. Airtightness champion on site to ensure the quality of airtightness but also to ensure thermal bridging details correctly constructed.

Ground floor: 175mm Leca Insufil expanded clay insulation and fill, followed above by 2 x 100mm Celotex FR5000 insulation, 1200g polyethylene DPM, a 250mm thick in-situ concrete raft slab, pumped hot water underfloor heating system, spreader plate, sitting between battens of 75mm Junckers NewEra Unibat timber sprung floor system. U-value: 0.074 W/m²K

Frame: 140mm wide x varying depth 17mm lamination glulam portals supplied through Pasquill.

Walls: 144 x 22mm untreated external oak rainscreen boarding, International Timber, with recessed allen head stainless steel slotted connectors to 38 x 25mm softwood battens at 525mm vertical centres, over 100mm thick Isover Frame Façade Slab insulation (incorporating weatherproof breathable membrane), over 18mm OSB3 board for racking rigidity, over 245mm JJI joist B+ I-beam at 525mm centres. 245mm Isover Timber Frame Batt 32 insulation with an Isover Vario KM Duplex vapour control and airtightness membrane. (In Sports hall only, glulam portal trusses sitting flush with the wall separated by 6mm shadow gaps either side). Internal lining: 12.5mm British Gyproc Soundbloc plasterboard plus 12.5mm Rigidur H Activair gypsum fibreboard lining. Locally Ecophon Akusto Wall C robust acoustic panels. U-value: 0.082 W/m²K

Roof: Follansbee KlassicKolors Standing Seam roofing system on Geotextile underlay, on 18mm OSB3 board, on 100mm Celotex FR5000 Insulation, on 18mm OSB3 Board, on 245mm JJI Joist A+ I-beam at 525mm centres. 245mm Isover Timber Frame Batt 32 insulation and Isover Vario KM Duplex vapour control and airtightness membrane, (in the sports hall only, glulam portal truss, set partially into the I-beam zone). Internal lining: 18mm OSB3 board with 40mm thick Ecophon Master SQ XL acoustic panels fixed direct to OSB. U-value: 0.081 W/m²K

WINDOWS & DOORS

Rehau Geneo composite windows and doors with 52mm triple glazing: 6mm coated Planiclear and cool-lite SKN 154 II glazing externally, followed inside by 16mm argon cavity, 4mm Planitherm ultra N II glazing, 16mm argon cavity, 6mm coated Planitherm ultra N II 6mm thick. PHI certified. Overall U-value: 0.79 W/m²K for windows, 1.10 W/m²K for doors

Glassolutions fixed rooflights structurally glazed with galvanized steel profiles, aluminium cover flashings, 50.8mm



triple glazed units SGG Coolite SKN154, 8.8mm SGG STADIP clear laminated glass externally, followed inside by 16mm argon cavity, 4mm SGG SECURIT clear toughened glass, 16mm argon cavity, 6mm SGG SECURIT toughened glass outer. Glazing U-value (centre pane): 0.53 W/m²K

Openable rooflights: Fakro triple glazed FTP-U5 centre-pivot wooden & aluminium Plateau motorised rooflight, Glazing 4-10-4-10-4mm with 33dB reduction, external tempered glass internal low-E coating.
Overall U-value: 0.97 W/m²K

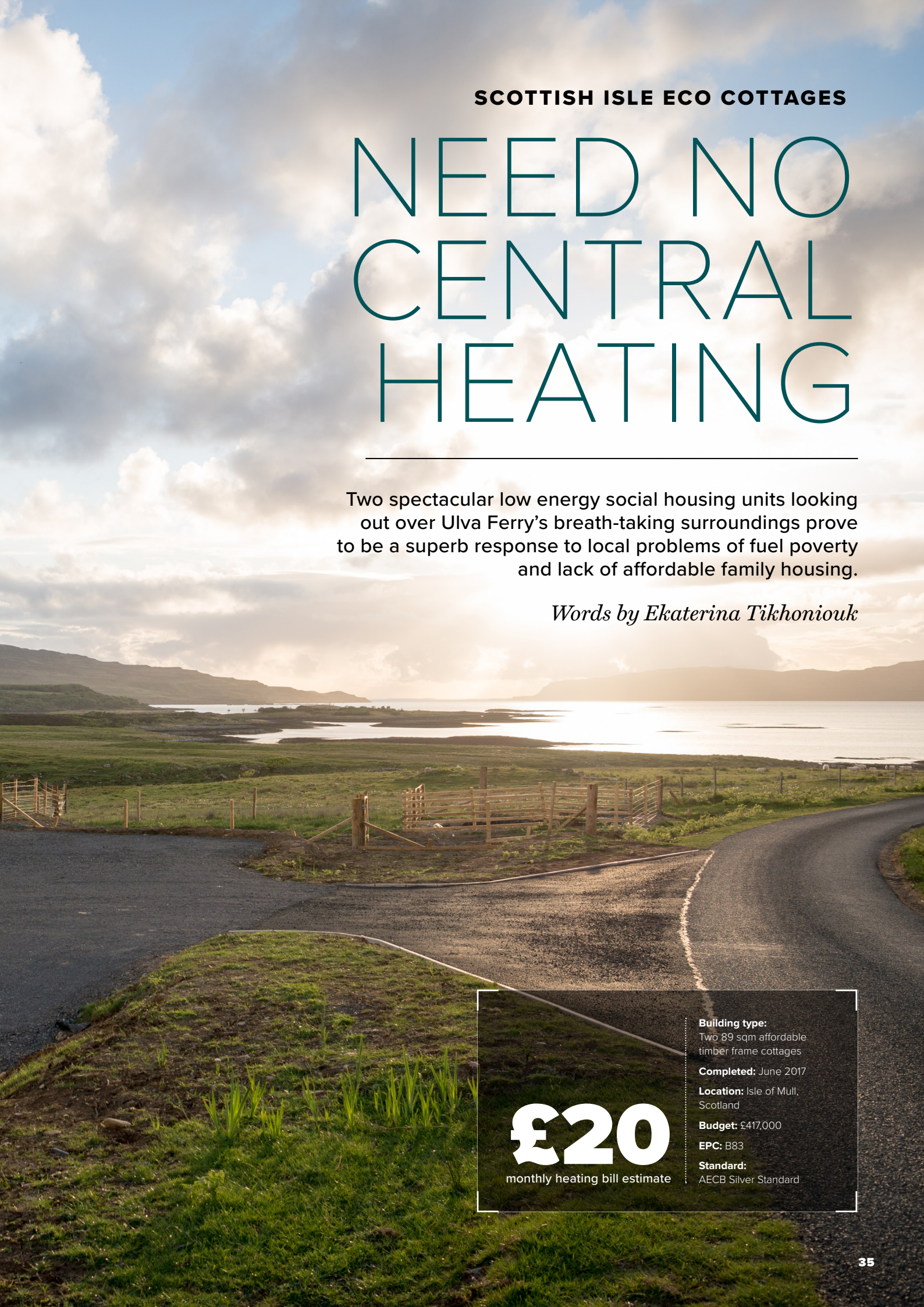
Heating system: Temporary oil-fired condensing boiler (site is moving to central biomass plant shortly), controlled via integral BMS system throughout. Underfloor heating.

Heat recovery ventilation: Swegon AB mechanical ventilation and heat recovery unit; Climaver pre-insulated supply and extract ducts.

Natural ventilation: Via opening windows and rooflights. Simple 'green light' user control indicates when external temperatures are high enough to open windows/rooflights without undermining the underfloor heating or MVHR. Summer night purging via BMS rooflights and (in extremely hot conditions) manually opened low-level sports hall windows.

Solar shading: External roller blinds to prevent solar gains, internal roller blinds to provide dim-out conditions for teaching and events.





SCOTTISH ISLE ECO COTTAGES

NEED NO CENTRAL HEATING

Two spectacular low energy social housing units looking out over Ulva Ferry's breath-taking surroundings prove to be a superb response to local problems of fuel poverty and lack of affordable family housing.

Words by Ekaterina Tikhoniouk

£20
monthly heating bill estimate

Building type: Two 89 sqm affordable timber frame cottages

Completed: June 2017

Location: Isle of Mull, Scotland

Budget: £417,000

EPC: B83

Standard: AECB Silver Standard



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The digital magazine is available to subscribers on www.passive.ie









Located by the sea in a designated national scenic area on Mull, the community-led social housing project at Ulva Ferry consists of two semi-detached three-bedroom houses. Wrapped in larch cladding and sheets of corrugated steel, they are very much in line with the local aesthetic — and house bright, airy, open-plan spaces.

The project came about when Ulva School was threatened with closure, due to local population decline brought about by the area's lack of affordable housing. This prompted the Ulva School Community Association to kick-start the affordable housing project, supported by the Mull and Iona Community Trust (MICT).

"Right from the outset, community members wanted energy efficient houses, because there's a real problem with fuel poverty locally," says Helen MacDonald, MICT's local development officer. "There's a lot of people living in very old, very poorly insulated houses, so they're spending a lot of money on heating…I've heard of people spending £80-£100 a week."

She explains that the emphasis of the project was on achieving an affordable and energy efficient building, and not necessarily on reaching a particular energy accreditation. However, as the chosen architecture firm Thorne Wyness has significant expertise in passive house design, it made sense to use the standard as a guide.

Architect Jenny Wyness chose cross-laminated timber – a smart engineered timber product which turns dimensional lumber into strong, rigid, dimensionally stable structural timber panels – for the building's structure, alongside sustainably-sourced Scottish larch for the cladding, and corrugated galvanised steel roof sheeting, which is "a cheap, traditional roofing material in the area." The design makes a feature of this stripped-back but beautifully detailed palette of materials.

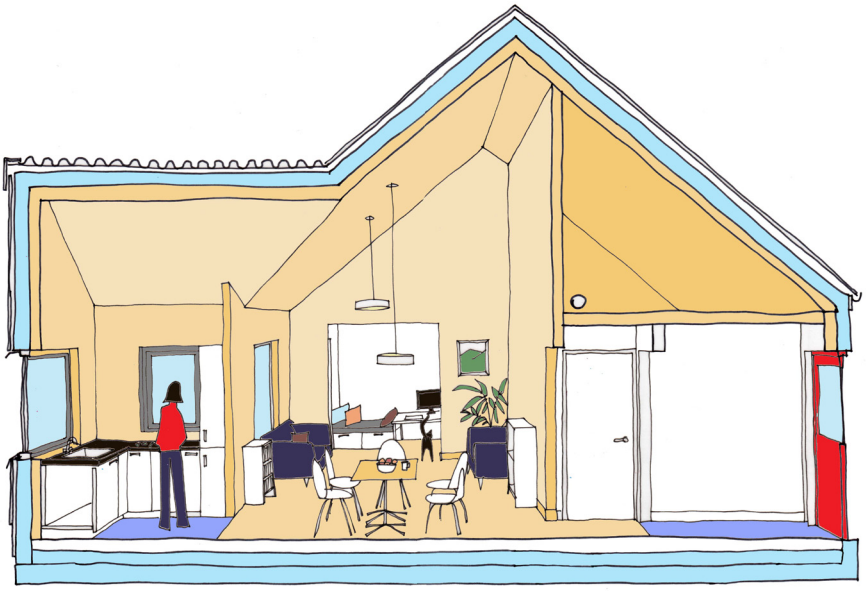
There's heat recovery ventilation and solar thermal collectors too, while space heating is primarily provided by Dimplex 1kW electric heaters in the main living spaces — there was no need for conventional central heating in these small, highly energy efficient homes. Pipe runs were further reduced by closely grouping wet services, reducing heat loss.

The houses are situated on quite an exposed site, which caused the team some challenges during construction. "We had concerns about manoeuvring the roofing panels into place in such a windy location. The wind also led to problems with handling and fixing the Kingspan insulation," Wyness says. "We also had problems when applying the Extoseal tape, because of the cold weather."

Despite this, the building achieved an airtightness of 0.39 air changes per hour, well

"The project came about when Ulva School was threatened with closure, due to local population decline.

Photography: Johnny Barrington



> These two new homes at Ulva Ferry are warm, comfortable and extremely energy efficient.

within the passive house standard of 0.6. But the project fell short of reaching the standard in other areas. "In general, we found passive house accreditation hard for a single-storey building," says Wyness — this is because single-storey buildings have a greater surface-to-volume ratio from which heat can escape, making it harder to reach the standard.

She believes the project's tight budget also had a significant impact, explaining: "If we had upped our wall insulation by another 40mm, we may have reached passive house classification... But the budget wouldn't allow it and we couldn't justify it." However, the two homes were certified to the less onerous AECB Silver Standard, which is based on passive house principles of fabric-first design and high quality ventilation, and is designed using the Passive House Planning Package software. The homes also happen to meet the Passive House Institute's standard for buildings which, for one reason or another, can't quite make passive: the PHI low energy building standard.

Since June 2017, the units have been home to two families with six children between them. And accreditations notwithstanding, it is clear that these two new homes at Ulva Ferry are warm, comfortable and extremely energy efficient — quite a world away from the draughty and poorly insulated Victorian-era farmhouses and cottages that some local families are used to inhabiting.

"The families are absolutely delighted with their new homes and have commented on how warm and comfortable the houses are," says Helen MacDonald. "Having been in private rental housing beforehand, they couldn't believe how low the heating costs would be."

The only minor issue experienced so far has been some summer overheating. "One of the families sleeps with the windows open at night, and have been opening windows in the evening due to a build-up of heat," says Jenny Wyness.

We're delighted with the project," Helen MacDonald summarises. "The houses are beautiful, I think they sit really nicely in their setting. And they're working well, we've had no problems since the occupants moved in."

All in all, the social housing in Ulva Ferry certainly proves that beauty, energy efficiency and affordability can all be achieved in unison, even in a landscape as harsh as Mull's.





CONSTRUCTION IN PROGRESS







1 Wire mesh in place to reinforce the concrete structural slab, below this is a DPM and 250mm Filcor 45 under-slab insulation; **2** the houses were built with cross laminated timber panels which provide strength, reduced construction time, and can help in minimising thermal bridges; **3** windows are Rationel triple glazed units with Extoseal Encors tape for sealing to the CLT panels





SELECTED PROJECT DETAILS

Clients: Mull and Iona Community Trust
Architect: Thorne Wyness Architects
Civil & structural engineer: David Narro Associates
Main contractor: Norman MacDonald Builders
Quantity surveyors: Allied Surveyors Scotland
Mechanical & electrical contractor: Ferguson Energy
Airtightness testing: Air Testing Scotland
Passive house consultant: Jenny Wyness
Energy rating assessment: Warm
Timber frame: Egoin
Wall insulation: Kingspan
Party wall insulation: Rockwool
Insulated foundation system: Cordek
Windows & doors: Rationel, via Architectural Doors & Windows Ltd
Airtightness products & Gutex insulation: Ecological Building Systems
Solar evacuated tubes & buffer tank: STI
Heat recovery ventilation: Paul Heat Recovery Scotland
Cladding: Russwood
Corrugated cladding: Accord Steel Cladding
Finance: Triodos



> “Community members wanted energy efficient houses, because there’s a real problem with fuel poverty locally.

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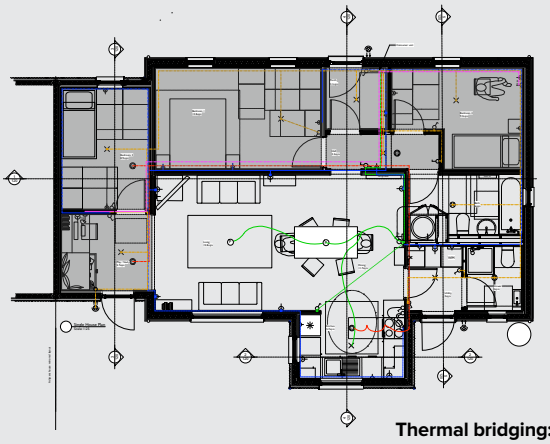
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IN DETAIL





Building type: Two 89 sqm semi-detached cross-laminated timber houses.

Location: Ulva Ferry, Isle of Mull

Passive house certification: Meets PHI low energy building standard, but not certified.

Space heating demand (PHPP): 17.51 kWh/m^2/yr (including storage area in roof)

Heat load (PHPP): 11.06 W/m^2

Primary energy demand (PHPP): 111kWh/m^2/yr

Heat loss form factor (PHPP): 4.38

Overheating (PHPP): 0%

Additional standards: AECB Silver Standard certified.

Airtightness (at 50 Pascals): 0.39 ACH or 0.378m^3/m^2/hr

Energy performance certificate (EPC): B83 (Scotland)

Measured energy consumption: 1,855 & 2,347 kWh for first 3.5 months of occupation (June to Sept 2017).

Thermal bridging: Cross-laminated timber construction entirely wrapped in Kingspan / Filcor resulted in the following Y-values (W/mK): External corner -0.033, Eaves -0.017, Foundation -0.198, Gable -0.038, Party wall 0.010, Ridge -0.026

Energy bills: Estimated in SAP at £496 per year / £41 per month (for heating, lighting, hot water, ventilation but not appliances) & with PHPP at £240 per year / £20 per month for space heating only (based on electricity price of 15.4p per kWh, inc VAT but not standing charges).

Ground floor: 150mm Type 1 hardcore sub-base with 50mm sand blinding, followed above by DPM and 250mm Filcor 45 under-slab insulation. 200mm concrete structural slab, 22mm particle board on baby joists as floor finish. 18mm ply to wet rooms. U-value: 0.135 W/m^2K

WALLS

Timber cladding: 27mm natural Russwood Scotlarch board-on-board timber cladding, on 25x50mm horizontal battens on 25x50mm vertical battens on build up as below.

Metal cladding: 3" sinusoidal cladding 0.7mm thick PVC Plastisol coated galvanised steel on 25x75mm vertical battens at 600mm centres with 50x50mm horizontal battens fixed at 600mm centres, with Timco 300INW 8 x 300 wafer head screw on build-up as below.

Build-up: Solitex Front Humida breather membrane, followed inside by 120mm Kingspan Kooltherm K12 rigid insulation, on Intello Plus airtightness membrane / vapour check, on 78mm cross-laminated timber panel. U-value: 0.149 W/m^2K

Roof: Traditional 3" corrugated cladding consisting of 0.7mm thick PVC Plastisol coated galvanised steel externally, with 25x75mm vertical battens at 600mm centres with 50x50mm horizontal battens fixed at 600mm centres, with Timco 300INW 8 x 300 wafer head screw on 180mm Kingspan Kooltherm K7 rigid insulation, on Intello Plus airtightness membrane and vapour check, on 120mm cross-laminated timber panel forming main roof structure or 78mm cross-laminated timber panel kitchen roof structure.
U-value: 0.10 W/m^2K

Windows, external doors & patio doors: Rationel triple glazed Aura windows, 4mm-20mm-4mm-20mm-4mm with argon fill, resting on 87x50mm timber buttress with Extoseal Encors tape to seal window sill and frame to CLT panel. Typical U-values: 0.82 W/m^2K (windows) & 0.87 W/m^2K (glazed doors).

Heating system: STI flat plate solar thermal collectors with Worldheat Superflow cylinder. Dimplex Q-rad 1kw heater in main space and Ecostrad TR 700W heated electric towel rail to bathrooms.

Ventilation: Zehnder CAQ 350 installed by Paul Heat Recovery Scotland with ComfoPipe Plus distribution systems. Summer bypass on systems. PHI certified heat recovery rate of 90%.

Water: Restricted waterflow showerheads. 200L water butts in gardens. Private water supply from bore hole and septic tank with infiltration bed.

Green materials: Russwood Scotlarch FSC-certified cladding sourced from sustainable forests in Scotland. FSC-certified cross-laminated timber structure by Egoin, timber sourced at factory forest.

THE WEST MIDLANDS ECO HOUSE

WITH NO ENERGY BILLS

With low electricity and gas bills and a feed-in tariff from its solar photovoltaic array, this simple, ecological timber frame passive house near the Welsh border manages to make about a £50 profit on annual energy costs.

Words by David W Smith

-£50 per annum

£730 feed-in tariff for solar energy minus £680 bill for electricity & gas

Building type: 140 sqm detached two-storey timber frame house

Completed: May 2015

Location: Garway, Herefordshire

Budget: £276,000 in total (£1,431 per sqm for finished house)

EPC: C79

Standard: Uncertified passive house





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Although they loved their beautiful 18th century cottage in the Herefordshire village of Garway, Dave Atkinson and his wife Claire reached a point three years ago when they were fed up with the draughts blowing through, and with the "bottomless pit" of money they spent on heating.

They decided to build a new timber house in the garden and sell the old cottage. At this stage, they had no intention to build a passive house, but a visit to a passive house in the nearby village of Clehonger changed their minds. "I was immediately hooked on passive house. The ambience felt just right," says Dave.

He approached Charles Grylls of Dempsey Decourcy Architects, who then teamed up with contractor Mike Whitfield — who had worked on the Clehonger house — and the experienced passive house consultant Nick Grant.

From the outset, the team had to operate under certain restrictions. First, Dave and Claire Atkinson's budget was tight, although one advantage was that the couple already owned the land. But ultimately the team managed to stick to his budget, and the completed 140 square metre 'Ty Pren' (meaning 'timber house' in Welsh) ended up costing £276,000 in total, a figure that included landscaping, a double garage and a workshop.

But there were also stylistic restrictions on the design. Local planning officers insisted that it had to be built in a ' cottagey' style to match the existing dwellings on the edge of Garway Common. "It had to be modest and simple, but this worked well with maintaining a continuous thermal and airtight envelope, which is so important in passive house design," said Charles Grylls. The airtightness test gave a result of 0.16 air changes per hour, one of the best ever recorded in the UK.

The team also pioneered a way of designing the building that helped to eliminate thermal bridging at the wall-to-floor junction. "Normally, the timber frame I-beams rest on the slab, or foundation, whereas we have perched the standard frames on the edge of the slab. Though it looks precarious, we worked closely with the engineer to maintain its integrity. We've done tests and it's fine," said Nick Grant. "When it's all finished it's incredibly strong. As far as I know we were the first to do passive houses in this way, but others have since copied the method."

This is part of an approach that Nick Grant calls " radical simplicity in passive house timber building" — fundamentally, it's all about simplifying construction details and designing them in from the start, so that achieving airtight and thermal bridge free construction is easier, faster and less costly.

For many architects, the term 'value engineering' has negative connotations of contractors substituting in cheaper materials and details, potentially undermining their design intent. Grant believes the term needs rescuing — genuine value engineering, he says, is really about designing simple, effective and repeatable details.

"It's about optimising design and performance, it's about not using more materials than you need to. And there's an elegance and deep beauty in that," he says. "Value engineering is usually misconstrued as cost-cutting, but really it should be about making things as efficient as possible, making them easier to build, and saving money and time. With real value engineering, the value increases if the cost comes down without sacrificing performance."

"There's no loss of performance, in fact there's improved performance. If sustainable building is to make any difference at all,





> I was immediately hooked on passive house. The ambience felt just right.



it must work really well and be affordable.”

Ty Pren was completed in May 2015, so Dave and Claire Atkinson have had more than two years to assess its energy performance. Dave says the house requires only five large bottles of propane gas per year to heat it. “We’ve put PV panels on the roof and the net gain from feed-in tariffs outweighs the amount of electricity and gas consumption. So, our net financial investment in energy is zero,” he said.

Though the couple love Ty Pren, Dave has notions of building another passive house — which would be his third self build. His limited budget at the outset of this project meant the plans for the house were actually adapted from an existing design Charles Gyrlls had drawn up, and he is toying with idea of building again — but this time starting with a blank sheet of paper, designing his dream home from scratch.

“There is a standard cliché that it takes three self builds to get exactly what you want,” he says. “I may never do it, it’s just a desire that I have.” But he describes Ty Pren as “brilliant”— and is such a convert to the passive house standard that he has even helped persuade the local parish council to build their new community centre to the standard, too.



Photography: George Mikurcik

SELECTED PROJECT DETAILS

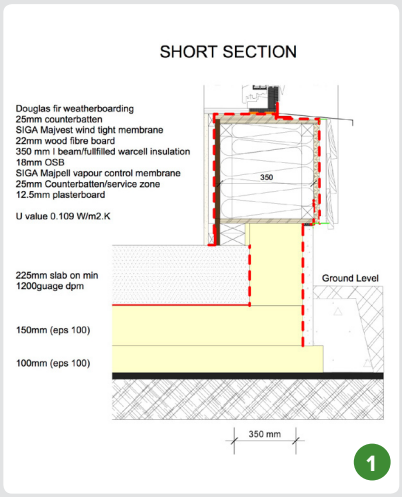
Clients: Dave & Claire Atkinson
Architect: Dempsey Decourcy Architects
Contractor: Mike Whitfield Construction
Passive house consultant: Elemental Solutions
Mechanical engineer: Alan Clarke
Structural engineer: Allan Pearce
Windows and thermal breaks: Green Building Store
Gas boiler: Worcester Bosch
MVHR: Paul, via Green Building Store
Airtightness products: Siga
Solar PV: Green Tech Renewables
Wind-tight membrane: Klober
Cellulose: Warmcel





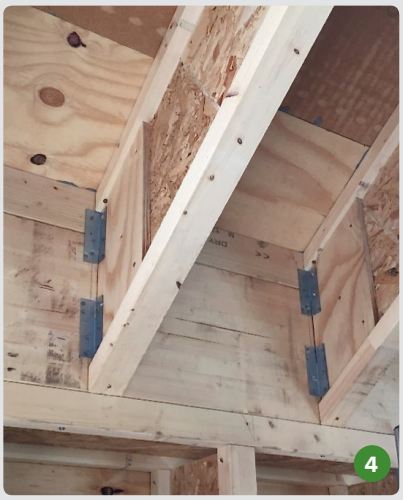


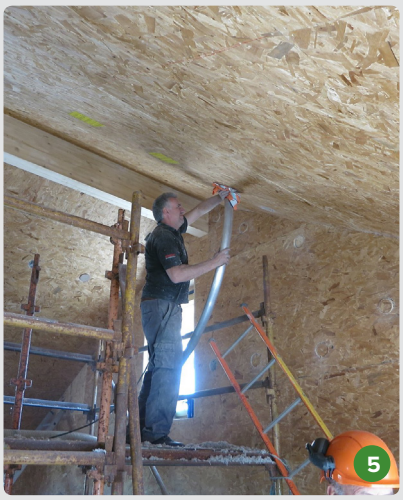
CONSTRUCTION IN PROGRESS



















1 Detailed cross section of the wall and foundation build-up; **2** erection of the timber frame superstructure on site; **3** timber-frame I-beams resting on the edge of the slab, which helps to eliminate thermal bridging at the wall-to-floor junction; **4** timber I-beams at the wall-roof connection; **5** pump-filling the roof with Warmcel cellulose insulation; **6** Klober Permo wind-tight membrane on installed on the roof of the house; **7** passive house consultant Nick Grant inspecting the installation of the windows, which are triple glazed and argon-filled timber units from Green Building Store; **8** Paul Jennings of Aldas carrying out an airtightness test — the result of 0.16 air changes per hour is one of the best ever recorded in the UK; **9** builder Mike Whitfield using smoke pencil to identify air leaks.



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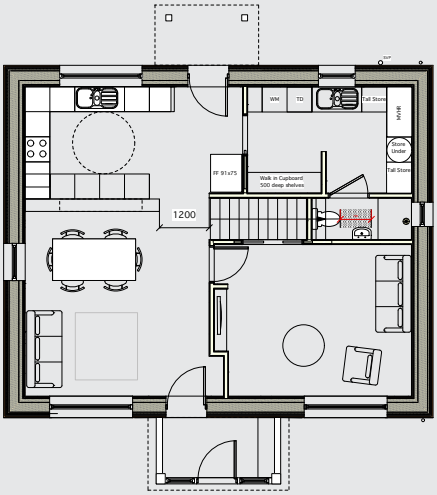
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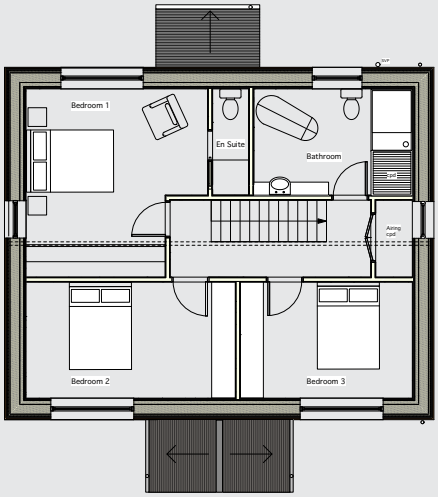




IN DETAIL



Ground Floor Plan



First Floor Plan

Building type: 140 (gross internal floor area) sqm detached two-storey timber frame house. Treated floor area 134 sqm. Plus workshop/ garage.

Passive house certification: Not certified

Budget: £276,000 in total for all works. £200,404 for house only excluding outbuilding, landscaping etc (so £1,431 per sqm).

Space heating demand (PHPP): 9 kWh/m^2/yr

Heat load (PHPP): 7 W/m^2

Primary energy demand (PHPP):
83 kWh/m^2/yr

Overheating (% time above 25C in PHPP): 1%

Heat loss form factor: 3.0

Airtightness (at 50 Pascals): 0.16 ACH

Energy performance certificate (EPC): C79

Energy bills: Approx £330 per year electricity bill & £350 year gas bill (total £680). However, Dave and Claire Atkinson receive approx £730 per year feed-in tariff for an estimated net energy profit of £50.

Thermal bridging:
All thermal bridges modelled.

Ground floor: Flat structural slab on 250mm EPS insulation. U-value: 0.135 x 0.68 ground reduction factor = 0.092W/m^2K

Walls: Douglas fir weatherboarding externally followed inside by 25mm counterbatten, Siga Majvest wind-tight membrane, 22mm wood fibre board, 350mm I-beams full-filled with Warmcel insulation, 18mm OSB, Siga Majpell vapour control membrane, 25mm counterbatten/service zone, 12.5mm plasterboard.
U-value: 0.109 W/m^2K

Roof: Reclaimed welsh slate externally, followed inside by 25mm batten, 25mm counterbatten, Klober Permo wind-tight membrane, 22mm wood fibre board, 400mm I-beam/full-filled Warmcel insulation, 18mm OSB, SIGA Majpell vapour control membrane, 12.5mm plasterboard. U-value: 0.091 W/m^2K

Windows: Green Building Store Progression triple glazed, argon-filled, timber windows with ultra low maintenance Thermowood facing. Passive House Institute certified.
Overall U-value: 0.68 W/m^2K

Heating system: 95% efficient Worcester Bosch Greenstar 12i condensing gas boiler system (LPG) supplying minimal radiator system and single coil hot water cylinder. Hot water cylinder Worcester Bosch SC 180, total volume 190 litres. Solar PV supplied to the hot water immersion heater when there is surplus PV power, controlled by Immersun unit.

Ventilation: Paul Novus 300 heat recovery system with integral frost protection. Passive house certified heat recovery efficiency rate of 94.4 % at 145m^3/h or 93% at 200m^3/h.

Electricity:
14 sqm solar photovoltaic totalling 3.8kW

Green materials: Recycled newspaper insulation, reclaimed slate, natural paints, locally sourced Douglas fir cladding, I-beams FSC-certified.

€161
per annum
estimated electricity costs for space heating

Building: 320 sqm detached home

Build method: Clay block with external insulation

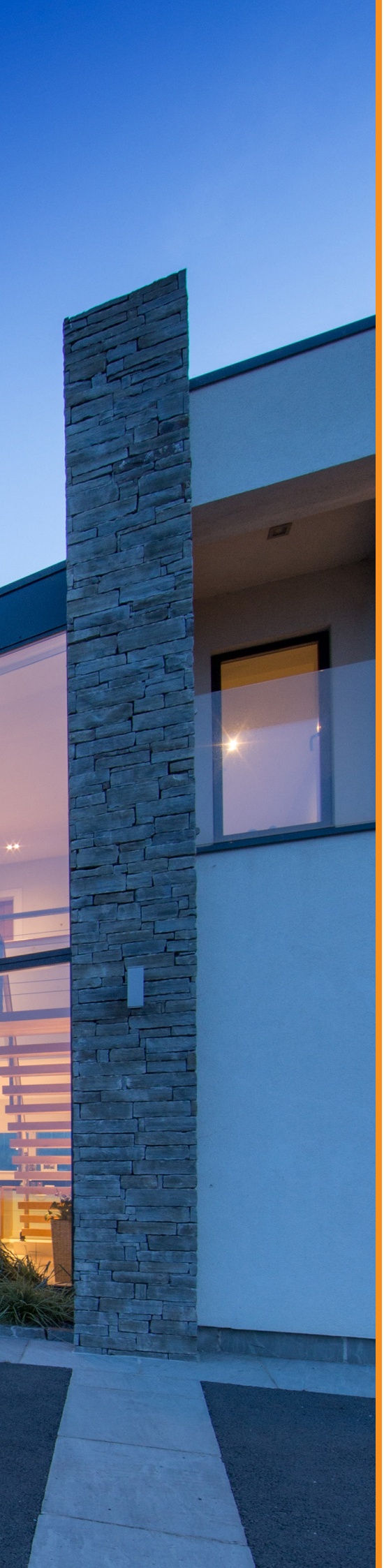
Location: Portmarnock, Co Dublin

Standard: Low energy building

Completion: June 2015

Budget: €600,000





THE STUNNING LOW ENERGY

SEASIDE HOME THAT'S BUILT FROM CLAY

Set on a picturesque coastal plot in north County Dublin, this eye-catching home was built from clay blocks and strives to balance energy efficiency and comfort with expansive sea views.

Words by John Hearne







A low energy house in Portmarnock, Co. Dublin makes full use of sea views while maintaining a high grade thermal envelope that doesn't overheat.

Architectural technologist and designer Des Crabbe of OA Studios is a veteran of several passive and low energy builds. He explains that the client was living in a poorly insulated 1950s era house which was both difficult and expensive to heat.

"The brief was not to build something fully passive in this case, but they did want a warm, energy efficient home. The other big challenge was that the house was less than 100 metres from the sea, and so would be subject to driving sea winds. We had to make sure that all of the materials chosen would be able to deal with that."

The planning authorities gave the go-ahead for the demolition of an existing house onsite, and granted permission for the new build, subject to maintaining the views enjoyed by neighbours on both sides. Keeping the new house to the same footprint as the old, Crabbe consulted with neighbours to ensure the project went smoothly. In addition, the client's son, architect Paul Murray, worked closely with Crabbe to arrive at the best possible design.

"We wanted the house to have a full 180 degree panoramic view of the sea, so we subdivided the building into three sections. We used stone spine walls to separate those areas as they run front to back, plus we included a fully glazed area in the centre of the building to the front in order to maximise the view."

This large glazed area had to face east, Crabbe explains, which was suboptimal in terms of passive solar gains. However, the use of high performance glazing minimised heat loss issues.

He was also concerned about the possibility of drafts as a result of convection currents as the air circulated across the glass. For this reason, and to provide radiant heat throughout the house, he specified underfloor heating used in combination with a low temperature air-to-water heat pump.

The house itself is built using Juwo poroton clay blocks, and externally insulated with graphite EPS. Crabbe initially looked at using 215mm concrete block on flat with external insulation, but the contractor, Pannoncelt Ltd had extensive experience with poroton.

"The poroton block was slightly more expensive but it's one of the best products on the market for controlling relative humidity inside a building. Also, because it is itself an insulator, it helps to limit thermal bridges," Crabbe says. The enhanced thermal properties of the block also allowed Crabbe to reduce the external insulation from 200mm to 100mm.

Airtightness is of course a priority in creating an efficient thermal envelope. Moreover, in order for the specified heat recovery ventilation system to perform at 90% efficiency, it was necessary for the house to have a sub 1.0 air change rate. Crabbe considered using the internal wet plaster finish as the airtightness layer but decided instead to go with a membrane used in conjunction with a battened service cavity internally.

"The way I see it on airtightness, you need to keep trades away from it and keep it as simple as possible," he says. In the end, the building achieved an airtightness score of 0.9 ACH at 50 Pascals – an impressive result for a building with a relatively complex design. According to Crabbe, the quality of the main contractor was critical here, and in the general quality of construction: "The building and detail achieved was only possible because Pannoncelt were dedicated with the highest level of workmanship I have ever worked with."

In order to reduce the risk of excessive solar gains (and thus overheating) from the extensive glazed surfaces, Crabbe specified openable windows at the front and the back of the house to allow for cross ventilation.

> The house was less than 100 metres from the sea, and so would be subject to driving sea winds.



Given the coastal location and the exposure, there's never any shortage of wind to facilitate house cooling when needed. Additionally, electric blinds on the south-facing windows helps to limit solar gain during the summer months.

Crabbe acknowledges that humidity was an issue in the early stages of occupancy, but as the house dried out, air quality improved dramatically. The house is thermostatically zoned, and – again in the early stages – there was some confusion with the client about how best to use the system. Crabbe produced an operation and maintenance manual to address that issue.

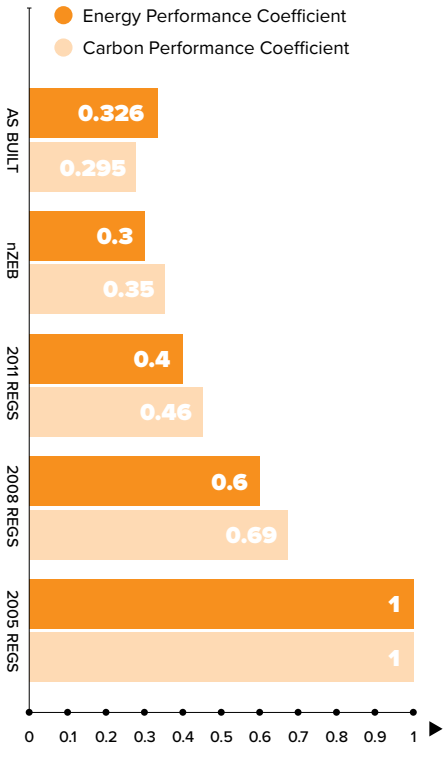
Homeowner Tony Murray says the house's energy bills are one-quarter that of his and his wife Yvonne's previous home on the site, which had a D1 BER and was of a similar size.

"Our main priority was to have a cosy and snug house with no drafts and at the same time plenty of fresh air," says Tony. "This has been a great success with many people commenting on the quality of the air."

"We are delighted with the result of all the effort that went into the design and build of the house. Particularly the specific finishes which make it such a unique house but yet a very comfortable home. It is great for entertaining with guests always commenting on the comfort and ambience."

"The location is amazing but the house enhances that even more. We are very lucky to wake up every day in such a wonderful house, and delighted to share it with our family and friends."

Explained: The ***Energy Performance Coefficent (EPC)*** and ***Carbon Performance Coefficient (CPC)*** measure the energy and carbon efficiency of buildings under the Irish building regulations. Here we compare the EPC and CPC for this dwelling to Ireland's proposed nZEB standard and to the current (2011) and past versions of Part L of the Irish building regulations. The lower the fraction, the better the score - so for instance a house with an EPC of 0.4 is 60% better than the 2005 regs.



> Given the coastal location and the exposure, there's never any shortage of wind to facilitate house cooling when needed.

Photography: Paul Tierney

SELECTED PROJECT DETAILS

Clients: Tony & Yvonne Murray
Architectural designer & project management: OA Studios
Civil & structural engineer: ETG Consulting Engineers
Main contractor: Pannoncelt
Energy consultant: Passivate
Airtightness tester: GreenBuild
Indicative BER: 2eva.ie
Poroton blocks: Juwo Poroton
Autoclaved aerated concrete blocks: Quinn Building Products
Roof, floor and upstand insulation: Xtratherm
Additional roof insulation: Knauf
External insulation: Weber
Airtightness products & cellulose insulation: Ecological Building Systems
Heat recovery ventilation: ProAir
Rainwater recycling: Kingspan Environmental
Windows & doors: Velfac







CONSTRUCTION IN PROGRESS



1 The walls of the house were constructed with Juwo Thermoplan poroton clay blocks; **2** the poroton walls are visible here rising up from the strip foundation, which was insulated with 150mm Xtratherm PIR board; **3** taping around joist ends for airtightness; **4** installation of the Webertherm XM graphite EPS external insulation system; **5** the large east-facing expanse of Velfac triple-glazed windows, which looks out over the Irish Sea; **6** rigid ductwork for the ProAir heat recovery ventilation system seen here in the ceiling service void, with the Intello vapour control and airtightness membrane visible on the inside of the wall build-up.

> The client reports that the house is now running perfectly, delivering the right combination of cheap heat and thermal comfort.









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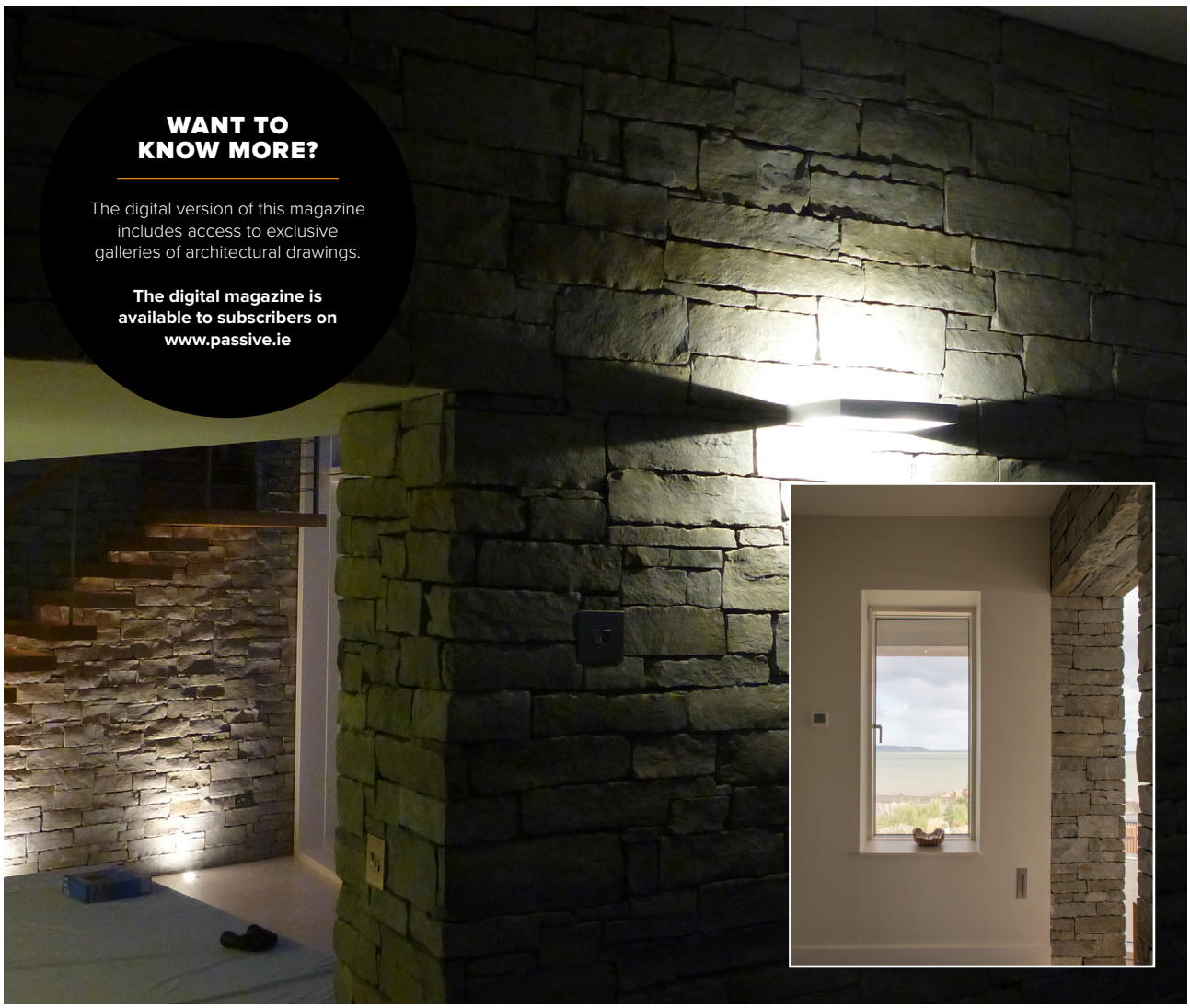
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IN DETAIL

Building type: 320 sqm detached house built with poroton clay block, externally insulated.

Location: Coast Rd, Portmarnock, Co. Dublin.

Completion date: June 2015

Budget: €600,000

Passive house certification: N/A

Energy performance coefficient (EPC): 0.326
Carbon performance coefficient (CPC): 0.295

Indicative BER: A2 (45.43 kWh/m²/yr)

Airtightness: 0.9 ACH at 50 Pa

Heating costs: No metred heating use available. Heat pump running costs for space heating calculated at €161 based on Deap figures, with a delivered energy requirement for 907 kWh/m²/yr to run the heat pump for space heating.

Energy bills: Average of €1,500 per year on electricity, which includes all the house's energy and heating use, bar a largely ornamental stove.

Thermal bridging: Course of Quinn Lite B7 insulated blocks below DPC Level, warm roof construction, 100mm graphite EPS external insulation, below DPC level external 50mm XPS insulation, 25mm XPS insulated window reveals.

Ground floor: Strip foundation insulated with 150mm Xtratherm PIR insulation.
U-value: 0.155 W/m²K

Walls: Silicone lime-based render on 100mm Webertherm XM Graphite EPS slab Insulation, on 300mm Juwo Thermoplan S9 poroton blocks with pro clima Intello airtight membrane forming airtight layer fitted internally, secured with 35x50mm battens forming service void with 12.5mm gypsum board. U-value: 0.158 W/m²K

Roof: Paralon membrane externally to manufacturers spec on 22mm WBP plywood, on firring pieces installed to achieve 1:80 fall to gutter valley on Solitex / Tyvex breathable membrane, on 100mm Xtratherm Thin-R slab insulation, on 225x44mm rafters at 400c/c with 300mm thick Earthwool insulation between rafters, on pro clima Intello airtight membrane, on 35x50mm battens to form 50mm service void with 12.5mm Gyproc Fireline 30 minute board.
U-value: 0.18 W/m²K

Windows: Velfac V200 triple glazed alu-clad windows, argon filled, low-E coating with an average overall U-value of 0.85 W/m²K installed.

Heating system: Samsung low temperature air-to-water heat pump, supplying underfloor heating throughout.

Ventilation: ProAir PA600LI heat recovery ventilation system. Passive House Institute certified heat recovery rate of 86% at 63-323 m/h

Water: Kingspan Environmental rainwater harvesting system.



> By keeping the airtightness layer outside, the workers inside didn't need to worry about puncturing membranes and compromising the layer.

€260
estimate for space heating, including €110 usage plus €150 of standing charges

Building: 1970s block of flats extended and upgraded to 1,856 sqm (TFA) building, including 34 socially rented apartments.

Build method: Externally insulated masonry

Location: Sallynoggin, Co. Dublin

Standard: Certified Enerphit

Completed: 2016

Budget: €3.5m

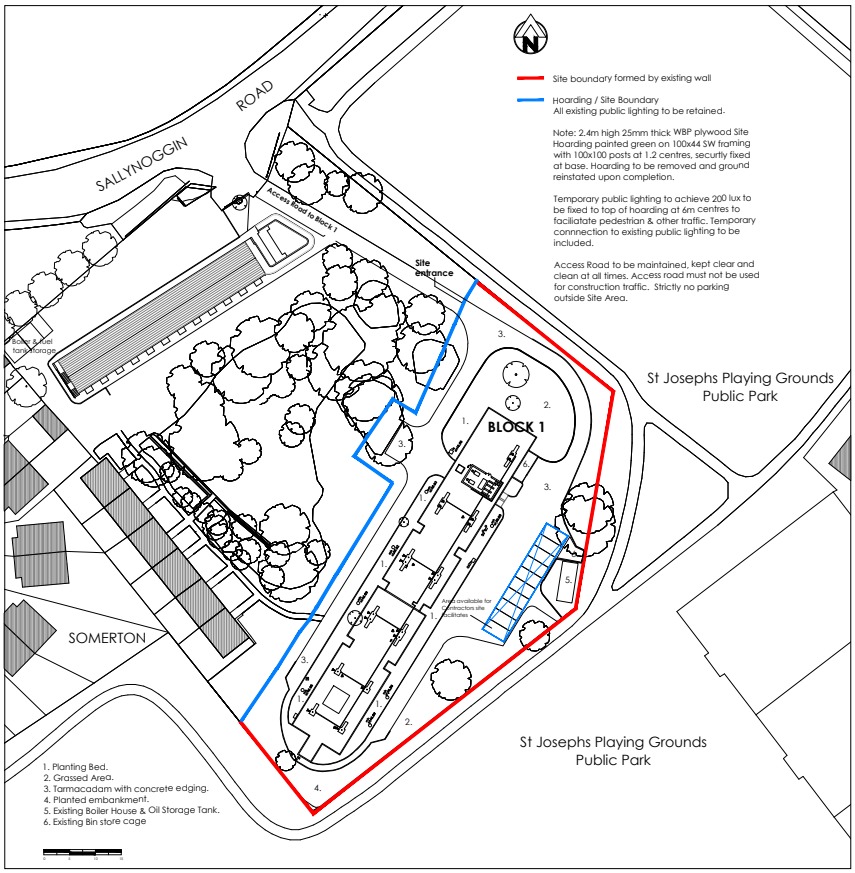
70S FLATS REBORN AS

WORLD CLASS PASSIVE SOCIAL HOUSING

Simultaneously tackling fuel poverty and climate change requires drastic action on deep retrofitting the existing housing stock – and fast. Dún Laoghaire-Rathdown's deep retrofit and renovation of Rochestown House may be Ireland's most significant retrofit to date – a fact reflected in the project picking up the sustainability award at the 2017 Irish Architecture Awards.

Words by John Hearne



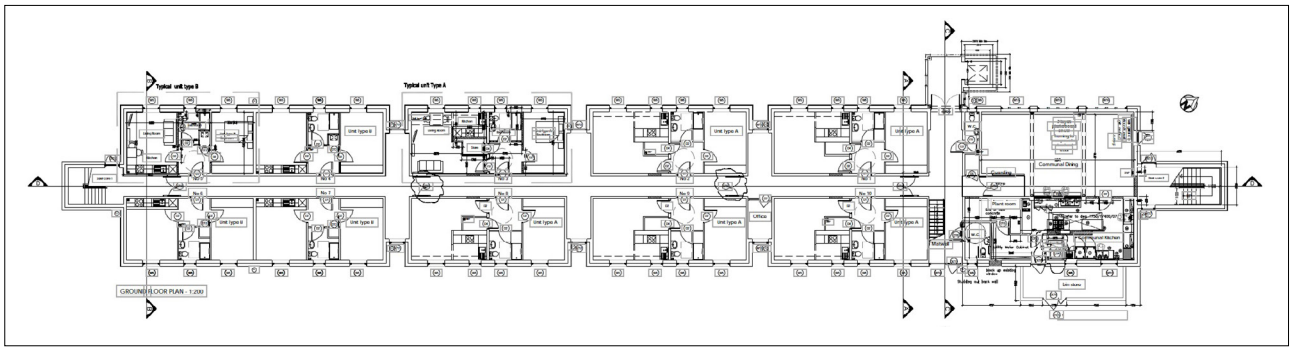


Two years ago, Rochestown House, a seventies era social housing apartment block in Dún Laoghaire, Co. Dublin was beginning to fall into disrepair. The council was faced with three choices. Tear it down and start again, do enough to maintain it, or refurbish.

"It was getting to a stage where the block was unrentable," says Sarah Clifford, project architect with Dún Laoghaire-Rathdown County Council. "The council couldn't move anyone in because of the condition of the units. They were damp, there was no one on the top floor because we had problems with the roof. All of the heating pipes were on the roof; they were circulating in the open air before they dropped down to the units, which reduced the efficiency of the heating, making running costs high. Something had to be done."

At the same time, passive design specialists, MosArt got in touch with the county council to talk about the Passive House Institute's Europhit programme. Europhit aims to promote and support step-by-step Enerphit projects in a variety of ways, including the provision of certification schemes and market incentive programmes. MosArt was looking for Irish case studies to participate in the programme, in return for which the council could avail of free passive house design consultancy.

Dún Laoghaire-Rathdown County Council has of course been at the forefront of sustain-







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able construction for years. Just last year, the local authority passed a motion that all new buildings be built to passive standards or equivalent. The decision to include Rochestown House in the Europhit project was very much in keeping with that ethos.

Mariana Moreira of MosArt came on board as passive house consultant and the design team set to work.

"The existing building was very poor on all fronts," says Moreira. "Very cold in winter, very expensive to run, the existing fabric had no insulation whatsoever. The air quality was very poor too – windows had to be kept open all the time to keep fresh air circulating."

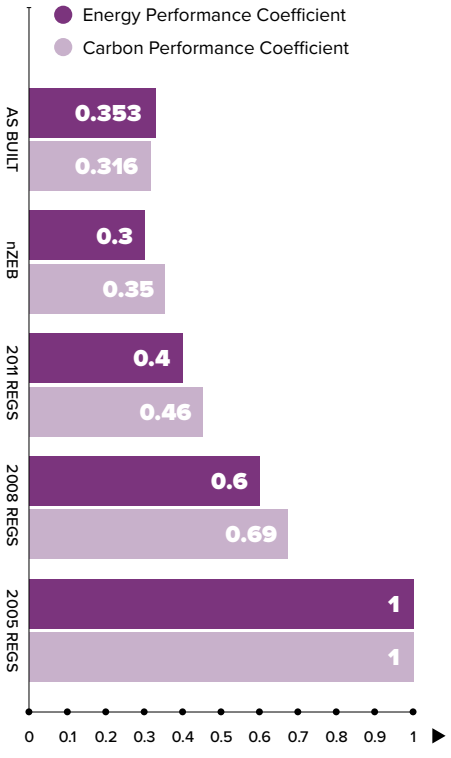
The layout of the existing apartments was also outdated – all thirty-four units were bedsits. Sarah Clifford explains that in the context of the council's housing policy, Rochestown House was aimed at downsizers. If the project was to succeed, it would have to provide an attractive alternative to tenants in larger houses, in order to free those up for families. The units therefore, would have to get bigger.

After exploring a number of possibilities, the design team decided that the best course of action was to go up, to retain the existing footprint and add a third storey. This would give sufficient space to open up the layout and provide more generous apartment sizes. At the end of the project, the team would end up 34 apartments – exactly the same number they had started with.

In order to keep the structure lightweight and stay within engineering constraints, aerated blocks were chosen to form the new third storey structure, together with a lightweight metal deck roof.

Arriving at an optimal airtightness strategy took a lot of thought and discussion. The team first explored the possibility of keeping the airtight layer on the inside of the structure, but the more they learned, the more difficult that option appeared.

The external wall of the old part of the building was comprised of concrete panels. By taping the joints of these panels, then extending that tape up onto the aerated blocks in the new floor, the airtightness layer was moved to the outside of the structure. This process was completed with the addition of a screed and a scud coat onto the aerated



Photography: Donal Murphy

blocks.

"That completed the envelope," says Clifford. "With a building of that size, there was an awful lot of M&E, but by keeping the airtightness layer outside, the workers inside didn't need to worry about puncturing membranes and compromising the layer."

The lack of any preservation order on the 70s era, pebble-dashed finish meant that the design team could wrap the building in external insulation, creating an even finish across new and old structures. A timber louver designed into the third floor facade meant that the thickness of the EPS had to be reduced in some areas. Mariana Moreira says that while this feature created a thermal bridge, the passive house software – PHPP – calculated that it could be borne without breaching any of the Enerphit thresholds, or without opening the structure up to condensation and mould growth risks.

Getting ventilation right also posed particular challenges in a building of this size and type.

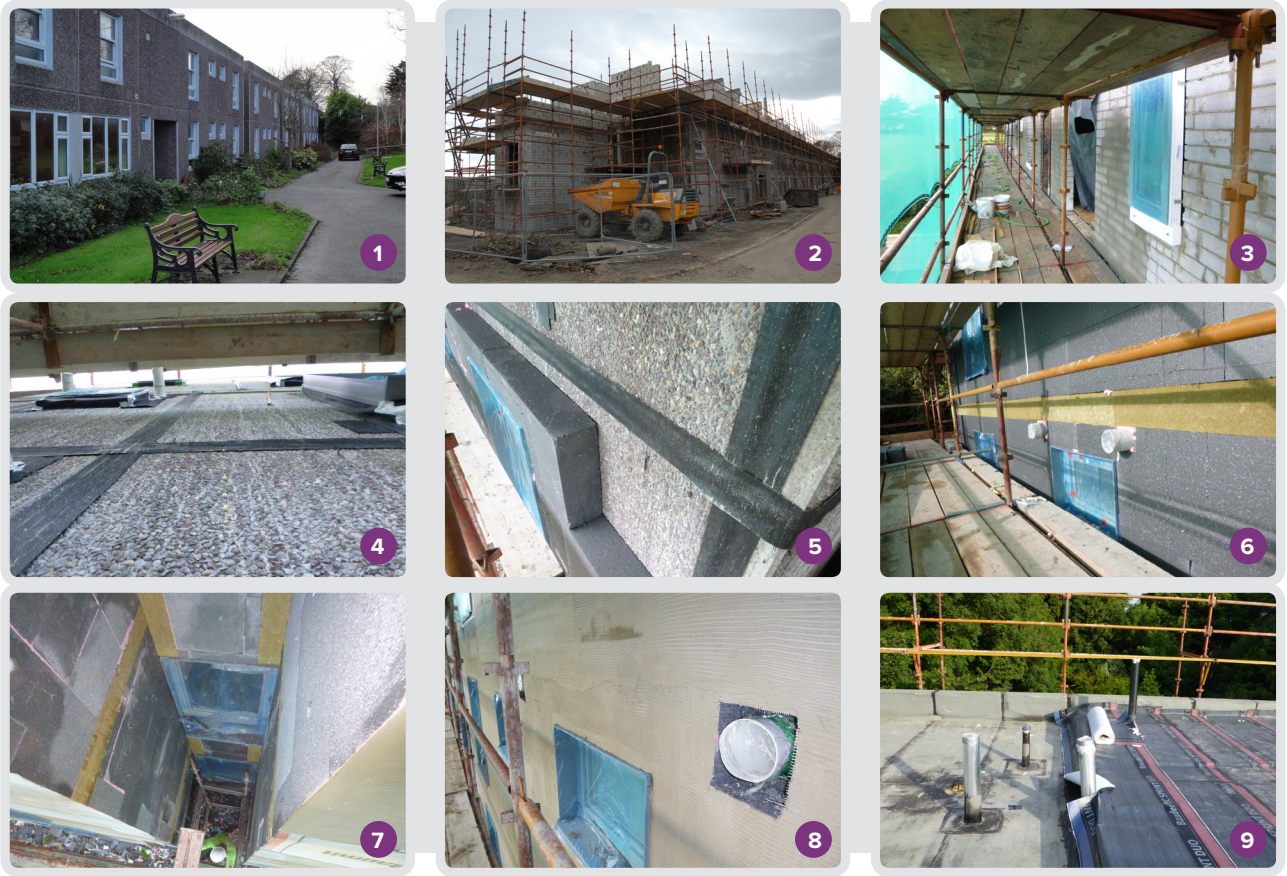
"We went through several options with the mechanical engineering consultant," says Moreira. "We first looked at three centralised ventilation systems that would be installed over the new storey." There were a few problems with this solution however. Ceiling heights were low, making it difficult to find space for ducting in overhead voids. In addition, using a dispersed ducting system would have required the installation of a high number of fire dampers, which would have generated a significant maintenance burden. The engineers were also concerned about the installation of heavy equipment on the roof of the building, not to the mention the added safety measures that would be necessary to access the equipment at that height.

Ultimately, the design team chose to install separate mechanical heat recovery ventilation units in every apartment. Each system is held in a lockable store in each apartment; filter changes and maintenance are the responsibility of the maintenance contractor. The only control confronting the tenants – many of whom are quite elderly – is the thermostat on the wall.

Mechanical contractor MPH brought an MVHR commissioning expert from Zehnder in the UK over for pre-commissioning guidance, to ensure the system was meeting the design parameters in terms of flow rates and temperature differentials, and hired an independent company to commission the systems.

The building is heated by a Dachs gas-fired condensing combined heat and power plant – which generates 5.5 kW electricity which is used to power lighting in the landlord areas, and a by-product of 14.8 kW of heat which is used for domestic hot water and – if ever required – space heating. The system is linked to a 500L thermal store, and is supported by three Remeha condensing gas boilers, if needed. If there's no demand for hot water and the thermal store has reached its set temperature, the CHP plant – which was

CONSTRUCTION IN PROGRESS



1 The Rochestown House flats prior to the refurbishment; **2** aerated concrete blocks were chosen to form new build elements, including a new third storey that allows for more generous apartment sizes; **3** new triple-glazed windows were installed outside the masonry layer so that the external insulation could wrap around them, and help prevent thermal bridging; **4** the airtightness layer was moved to the outside of the structure by taping the joints of the existing concrete panels, then extending that tape up onto the aerated blocks in the new floor; **5** Aerobord platinum EPS external insulation being fitted to the original concrete panel walls; **6** & **7** the new window frames visible here in the external insulation layer, including Rockwool fire breaks; **8** openings for exhaust and supply intakes for the new Zehnder heat recovery ventilation system, seen here prior to being insulated and airtightened; **9** installation of the Bauder bitumen roofing membrane.



> It's never been below 20 degrees – it's as warm as toast.

sized for the base thermal load – switches off.

Tenant David Falconer moved into one of the apartments on the south east facing aspect of the building just over a year ago, having come from a thirty-year old apartment building in Sandycove. So far, he's lived through one winter in Dún Laoghaire, and says that he hasn't yet had to turn on the heating.

"There's been no need for heating at all. The side of the building we're on faces the south east, there's so much insulation, and the windows are so good that even a little sun – hazy, patchy sun – is sufficient to warm up the apartment. It's never been below 20 degrees – it's as warm as toast."

There is a downside however, and that's overheating.

"In summer, we have had great difficulties with heat. On one day in May, we had 27.3C inside our apartment, and it was uncomfortably hot on quite a few days in summer."

There are no shading or other features to mitigate this problem, so Falconer has installed Venetian blinds and bought fans for bedroom and living room areas. When we spoke over the phone – on a mild September morning – the temperature in the living room was above 24C.

AN ESTIMATE OF HEATING & HOT WATER COSTS

What's the net effect of the energy saving efforts at Rochestown House in terms of running cost reductions? While the scheme consisted of 34 units before and after the upgrade, a direct comparison is rendered impossible by the fact that the renovated building was increased by a storey, with the existing 34 bedsits replaced by 34 larger apartments.

While the results of ongoing monitoring were unavailable for this article, a quick analysis by Passive House Plus suggests that a typical 43.7 sqm apartment at Rochestown House would be using just under 1100 kWh of energy for space heating annually, based on the calculated space heating demand of 25 kWh/m^2/yr. It's tricky to convert that into an estimated annual cost, because of the way energy bills are typically broken down for district heating.

In the absence of data from Dun Laoghaire-Rathdown, Passive House Plus took price data from a private apartment scheme in Dun Laoghaire heated with district heating, billed through SnugZone, which includes a cost per unit of less than 10C per kWh, in addition to a daily standing charge of 93C, or an annual figure of €339. But that is levied for a service including space heating and domestic hot water use. At Rochestown House, the calculated space heating demand of 25 kWh/m^2/yr is accompanied with a domestic hot water demand of 32 kWh/m^2/yr. Without the standing charges, the calculated space heating and domestic hot water costs work out at €109 and €138 respectively, or a total of €247. The reference standing charge more than doubles that, bringing the total to €587, or €260 for space heating and €327 if the standing charge is divided proportionately. It's worth noting that the real space heating figure may be lower, if the zero heating use claim of the tenant interviewed for this article is indicative.

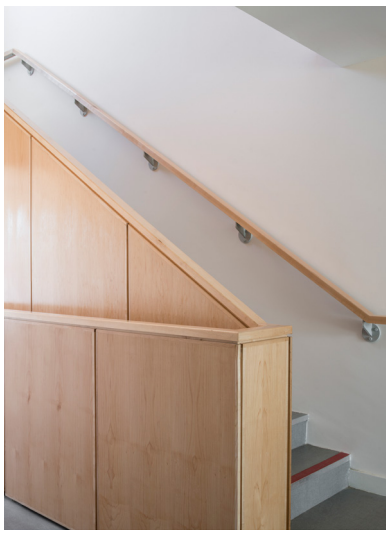
The opening sections of the windows are quite small, and because his apartment faces away from prevailing winds, it is difficult to introduce any natural air movement into the living room or bedroom.

The passive house software does evaluate overheating risk. In order to meet Enerphit criteria, the internal air temperature should not climb above 25C any more than 10% of the time during the year. In Rochestown House, the analysis concluded that there was actually zero risk of overheating, that the temperature would not move above 25C at any time.

The issue here however is that the software calculates a result based on the whole building rather than on each individual housing unit. The overheating risk in a number of individual apartments was not identified therefore during the planning stages.

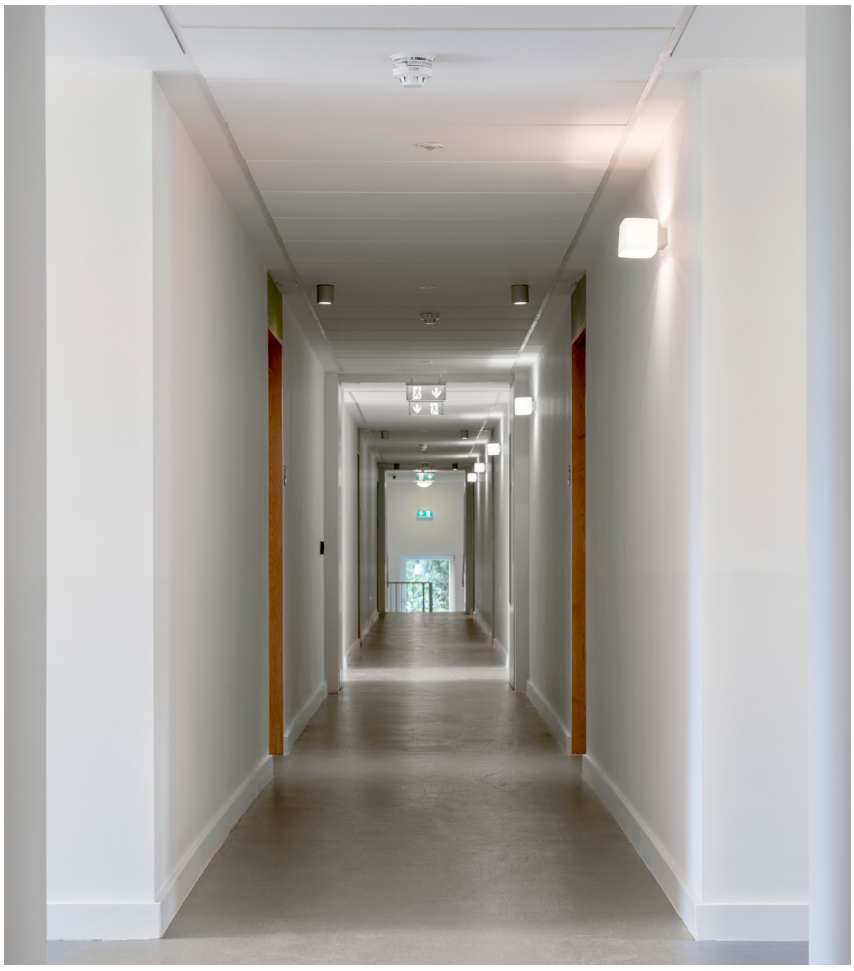
Sarah Clifford says that the county council is aware of the problem with a small number of the apartments on the south east side of the building and is monitoring the issue.

It's also worth noting that despite the fact that PHPP failed to capture the overheating risk in individual units, overheating risk is at least captured by the software. Building regulations have nothing to say about what has become an increasingly important issue in low energy building – there's no target set in terms of maximum temperatures that a building must be designed not to exceed.









SELECTED PROJECT DETAILS

Client & architects: Dún Laoghaire-Rathdown County Council
M&E engineer: Ramsay Cox Associates
Civil / structural engineer: Hanley Pepper Associates
Passive house consultants: MosArt
Fire consultant: John A McCarthy Fire Safety Consultant
Main contractor: Manley Construction
Quantity surveyors: Walsh Associates
Mechanical contractor: MPH Mechanical Plumbing Heating Ltd
Electrical contractor: D&N Group Ltd
Airtightness tester / consultant: Advanced Airtight Solutions
Ventilation system commissioning: SIBS Group
External insulation system: Baumit
External insulation contractor: EcoClad
Floor insulation: Ballytherm
Roof system: Bauder
Additional roof insulation: Rockwool
Windows: Pozbud, via Carroll Joinery
Curtain walling and external doors: Reynaers, via Carroll Joinery
Thermal breaks: Partel
Thermal blocks: Quinn Building Products
Heat recovery ventilation: Zehnder, via Versatile
Condensing gas boilers: Eurogas
District heating consumer units: Danfoss
CHP: Glenergy Ltd
Airtightness products: Alfa, via Proline Hardware
Flooring: Polyflor



IN DETAIL

Building type: 1,856 sqm (TFA) masonry block of 34 social housing apartments, externally insulated & retrofitted to the Enerphit standard.

Location:
Sallynoggin, Dún Laoghaire, Co Dublin.

Completion date: 2016

Budget: €3,519,500

Enerphit certification: Certified

BER
Before: F to G (407 to 616 kWh/m²/yr)
After: B2 to A3 BER (56-110 kWh/m²/yr)

Energy performance co-efficient (EPC):
0.353 (new build only)
Carbon performance co-efficient (CPC):
0.316 (new build only)

SPACE HEATING DEMAND
Before: 354 kWh/m²/yr
After: 25 kWh/m²/yr

HEAT LOAD
Before: 109 W/m²
After: 11 W/m²

PRIMARY ENERGY DEMAND (PHPP)
Before: 682 kWh/m²/yr
After: 92 kWh/m²/yr

Primary energy renewable (PHPP):
82 kWh/m²/yr

Heat loss form factor: 2.01

Overheating (PHPP):
0% (of hours above 25C)

Annual heating costs (calculated): €109 of space heating use and €339 standing charge for heating and hot water service, based on typical apartment size of circa 43.7 sqm, taking indicative costs from SnugZone (unit cost of 9.976c per kWh, and standing charge of 93.07c per day.

AIRTIGHTNESS (AT 50 PASCALS)
Before: 5.0 ACH
After: 0.78 ACH

Upgraded walls: Original 232mm thick concrete panel walls externally insulated with Baumit system including 200mm / 250mm Aerobord Platinum EPS insulation.
U-value before upgrade: 3.75 W/m²K.
U-values after: 0.12 / 0.15 W/m²K

New walls: 215mm aerated concrete block externally insulated with Baumit system including 150mm or 200mm Aerobord Platinum EPS. U-value: 0.13 / 0.16 W/m²K

New roof: Bauder flat metal deck roof insulated with 150mm phenolic insulation and 50mm Rockwool acoustic insulation.
U-value: 0.13 W/m²K

Ground floor: New floor areas featuring 150mm concrete slab with 120mm Ballytherm PIR insulation underneath.
U-value: 0.176 W/m²K. Existing uninsulated floor areas with 150mm concrete slab only.
U-value: 4.3 W/m²K

Windows
Before: Double glazed PVC windows with overall U-value of approximately 1.4 W/m²K

New triple glazed windows: Pozbud Passive Ultima, thermally broken timber-framed windows with Aerogel insulation and aluminium cladding externally. Vitrotherm triple glazing with argon fill and g-value of 64%.
Overall U-value: 0.99 W/m²K

HEATING SYSTEM
Before: Oil-fired district heating. All plant replaced in upgrade.
After: District heating system, fed from the central plant room at ground floor level, with each unit having a district heating station with local control of heating circuit and instantaneous generation of hot water via a plate heat exchanger. Heating provided via a Dachs gas condensing micro-CHP unit – 5.5 kW electrical, 14.8 kW thermal, up to 99% efficiency in condensing mode, supported by three high-efficiency Remeha Quinta Pro 90 kW condensing gas boilers, linked to a 500L buffer tank. Danfoss VMTD-F single plate heat exchanger units provide instant hot water and space heating to each apartment. On the return from each radiator there's a valve which throttles the flow rate down if the return temperature exceeds 50C to enable the condensing gas boilers to operate in condensing mode. Each apartment has a Danfoss heat interface unit including an energy meter.

VENTILATION
Before: No ventilation system. Reliant on infiltration, chimney and opening of windows for air changes.
After: Zehnder Comfoair 180 mechanical ventilation with heat recovery system to each apartment, externally accessible for maintenance. Passive House Institute certified heat recovery of 82%, and automatic summer bypass.

MAYO PASSIVE HOUSE

MAKES YOU FORGET THE WEATHER...

Homeowners Michael and Paula Sheridan say that, living in their farmhouse-inspired Mayo passive house — which includes a highly unorthodox heating system — it's easy to completely forget how cold it is outside.

Words by John Cradden



WANT TO KNOW MORE?

The digital version of this magazine includes access to exclusive galleries of architectural drawings.

The digital magazine is available to subscribers on www.passive.ie

€900

total annual energy bills for all usage

€220

estimated annual space heating costs, assuming no solar thermal contribution

Building type:
272 sqm wide cavity wall house

Completed: September 2014

Location: Foxford, Co Mayo

Budget: €306,203

BER: A3 (indicative)

Standard:
Uncertified passive house



Even after three years living in a passive house, Michael and Paula Sheridan still get a little confused.

"We could be in the house and we could be walking around in just a T-shirt or what have you, and then you gather the dogs and you open the door to go out for a walk and then you suddenly realise just how cold it is outside," says Michael Sheridan.

"And it's a strange sensation. You are looking out on the environment. It might even look like a nice day. You open the door and then all of a sudden you feel the chill wind and you are thinking, oh, I'll have to go back in and get a jumper or something because I ain't going to go far with just a T-shirt in this."

The enveloping sense of warmth extends from the built-in garage through to the utility room. "The heating is just completely unobtrusive," he says. "And it's only around the winter-time that we actually need any heating at all, because the solar gain alone does everything else."

Michael says visitors to the house — outside Foxford in County Mayo — comment on how lovely and warm it is, and say the house is noticeably free of stuffiness, and has very little dust. "Paula was saying…she could nearly dust the house once a year now. And it's just there's nothing coming in."

It might have taken nine years for Michael and Paula to move in from the time they decided to build, but it was clearly a journey worth taking. Although construction didn't commence until May 2013, the couple had met up with Jay Stuart in Dublin some seven or eight years previously. He was one of very few architects in Ireland at the time with passive house know-how.

He suggested that the cost of travelling up and down to Mayo would weigh too heavily on the couple's limited budget, and suggested they find a local practice. So they approached the local council and it suggested Westport-based architect Cuala McGann (now of McGann-Bauduin Architects).

"So we went to Cuala and we seemed to hit it off straight away, because as soon as we mentioned 'passive' her eyes lit up, because she was thinking of building a passive house [for herself] at the same time," says Michael.

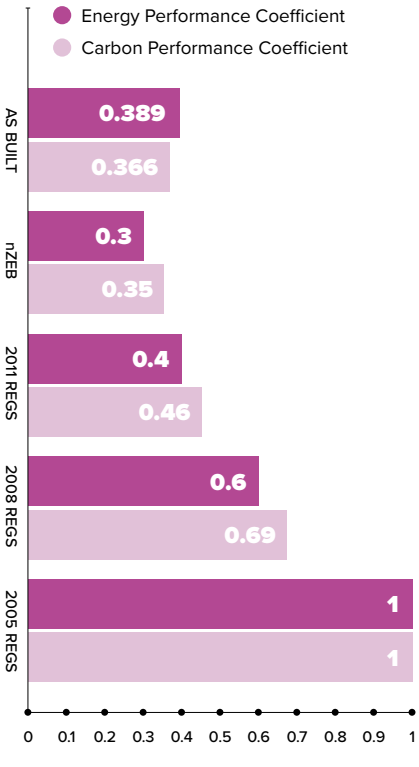
The couple had long fancied a passive house. Michael had heard of the standard while living in Germany, and later learned more as part of a project on construction costs for an engineering diploma course he studied in Scotland.

The project was somewhat bedevilled with the considerable intricacies and timeframes involved with gaining planning permission for a one-off build on a greenfield site in rural Ireland, but in a way the timing worked out well. McGann trained up on the passive house standard and PHPP in the meantime through her own home-building project — skills she later augmented by signing up to one of the first training courses delivered in Ireland by the Passive House Academy in 2010.

The next challenge for the designers came at the detailed planning stage. The original design intended to sink the bottom half of













> It's a strange sensation. You look out - it might look like a nice day. You open the door and then all of a sudden you feel the chill wind and you think 'oh, I'll have to go back in and get a jumper'.

the house into the ground, with some excavation required. But the local council objected, leading to a major revamp into a two-storey shape, built with the garage tucked into the east side of the house so as not to obstruct views or light. But the simple and compact design did enable the finished dwelling to achieve the passive house standard with an economical budget, according to McGann.

"The orientation of the site was also a very important factor in that the private amenity areas are south-facing with very little shading. We found that we didn't need to increase the levels of insulation enormously to achieve the required maximum heat load levels," she says. The balcony helps to prevent overheating by shading the living room and back room on the south façade.

Working with Galway-based contractor James Kearney of K & K Passive Homes, the team opted for details that he had experience with, including a passive slab foundation system and wide masonry cavity walls with full-fill bead insulation. Wide cavity walls are still somewhat rare in passive new builds compared to single leaf with external insulation, or timber frame, but Kearney was keen to work with this system, and McGann says that it proved straightforward to build and was somewhat cheaper in this case than an external insulated render.

The heating strategy is certainly unorthodox. A 60 tube solar thermal array feeds a 500 litre cylinder, aided by an immersion timed to avail of night rate electricity. This supplies underfloor heating downstairs in two zones – thermostatically controlled – on timers for the front and back of the house. "They kick in a fair bit in winter," says Michael Sheridan. Added to that is a form of direct electrical heating more commonly used to prevent pipes freezing in cold climates – a trace wire, in this case contained within the slab towards the perimeters. This is set at 25.5C for the six month long heating season and runs from 11pm to 7am – triggered by a temperature sensor in a walk-in wardrobe on an internal wall. The heating system doesn't travel above the ground floor, with upstairs rooms being solely reliant on passive solar gains and recovered heat from the Dantherm ventilation system, onto which Sheridan plans to install a post heater.

SELECTED PROJECT DETAILS

Clients: Michael & Paula Sheridan
Architect: McGann-Bauduin Architects
Civil & structural engineer: Fergal McGrane Associates
Main contractor: K & K Passive Homes Ltd
Mechanical contractor: Ower Plumbing & Heating
Electrical contractor: Sean Gavin Electrical
Airtightness testing: Energy Matters
Cavity wall insulation contractor: Walter Moran Insulation
Cavity insulation & insulated foundation system: Kingspan
Mineral wool insulation: Isover
Airtightness products: Isover, DuPont
Windows & doors: Munster Joinery
Thermally broken wall ties: Ancon
MVHR: Dantherm, via BEAM
Solar thermal: Joule

Photography: Olivier Bauduin

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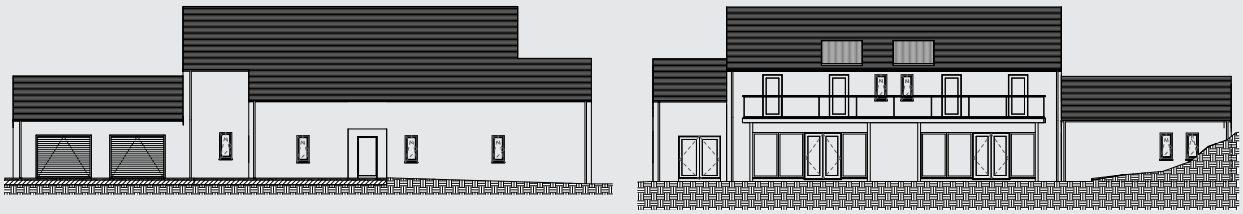
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IN DETAIL



Building type: Detached 272 sqm cavity wall house with 42 sqm integrated double garage within thermal envelope

Budget: €306,203 gross (excludes some client finishes)

Passive house certification: Not certified

Space heating demand (PHPP): 9 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 91 kWh/m²/yr

Overheating (% of time over 25C in PHPP): 0.0%

Heat loss form factor: 2.87

Indicative BER: A3 (56.51 kWh/m²/yr) - excluding trace wire energy use

Energy performance coefficient (EPC): 0.389
Carbon performance coefficient (CPC): 0.366

Airtightness (at 50 PA): 0.58 ACH or 0.97m3/m²/hr
Energy bills: Average annual electricity bill of €900 including VAT and standing charges.

Heating costs: Estimated at €220 based on PHPP-calculated space heating demand at assumed night rate electricity tariff of 9c per kWh.

Thermal bridging: Proprietary Supergrund (now Kingspan) insulated passive foundation / floor system to form ground floor slab & foundations, proprietary TeploTie low thermal conductivity cavity wall ties, thermally broken window frames, insulated rigid insulation cavity closers to all reveals. Y-value: 0.08 W/mK (based on ACDs and numerical simulations):

Ground floor: Kingspan insulated passive foundation / floor system incorporating 300mm structural EPS insulation under slab with min 100mm structural EPS wrapped around foundation ring beams.
U-value: 0.11 W/m²K

Walls: 25mm white sand-cement rendered finish externally, followed inside by 100mm concrete blockwork outer leaf, 300mm cavity fully insulated with proprietary Ecobead platinum grade EPS cavity bead insulation with max. conductivity of 0.035W/mK. TeploTie low conductivity wall ties suitable for 300mm cavity, 100mm concrete blockwork inner leaf with 15mm plaster finish internally including airtight scratch coat.
U-value: 0.11 W/m²K

Roof: Natural slate finish externally on 50x35 battens / counter battens, followed underneath by breathable roofing underlay, 225mm timber rafters insulated with 220mm Isover Metac insulation (with max 0.035W/mK thermal conductivity) breathable airtightness / vapour control membrane, 50mm insulation backed plasterboard ceiling.
U-value: 0.14 W/m²K

Windows: Passive House certified Munster Joinery Ecoclad 120+ triple glazed aluminium-clad windows, with argon filling and an overall U-value of 0.85 W/m²K installed.

Heating: 60 tube Joule solar thermal system with 3.62KW output, supplying underfloor heating and 500 litre solar cylinder plus immersion heater.

Ventilation: Dantherm HCH 8 heat recovery ventilation system, Passive House Institute certified to have heat recovery rate of 95%.

CONSTRUCTION IN PROGRESS



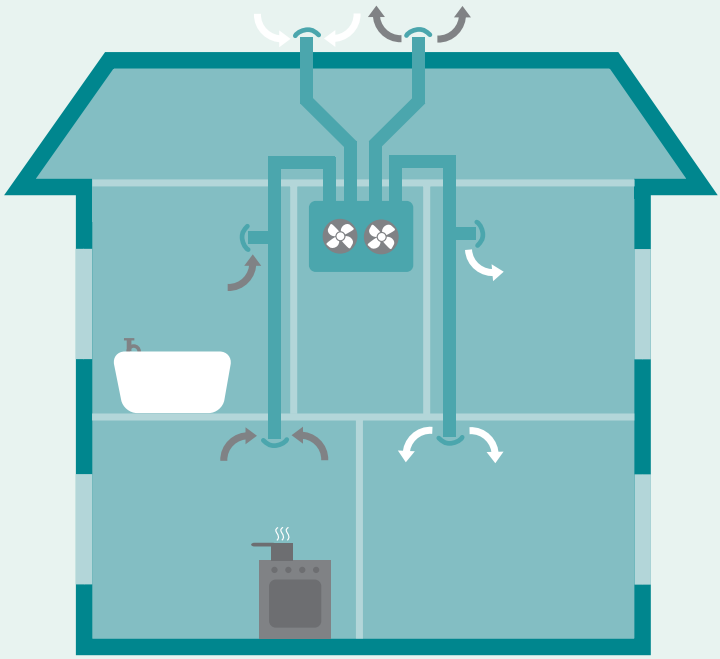




1 The Kingspan insulated passive foundation system, incorporating 300mm structural EPS insulation under slab, practically eliminates the critical wall-to-floor thermal bridge; **2** the house features 200mm wide masonry cavity walls with full-fill platinum bead insulation; **3** the Isover Vario airtightness and vapour control membrane installed to the underside of the roof structure.

The PH+ guide to HEAT RECOVERY VENTILATION

No technology is a panacea. While heat recovery ventilation is an invaluable way to maintain indoor air quality in low energy buildings and minimise the loss of precious heat, there are several issues to address to ensure optimal performance. Ventilation expert Ian Mawditt, a technical advisor on Part F of England's building regulations, has decades of experience in field investigations of indoor air quality and ventilation effectiveness, and has co-authored several related reports, including a meta study of heat recovery ventilation system performance in UK homes. This guide, which focuses on centralised or ducted whole house heat recovery systems, is essential reading to anyone considering such a system.



It is widely acknowledged that all buildings need to be ventilated for the health and comfort of the people inside. In low energy and, usually, more airtight buildings there is growing concern that buildings can be inadequately ventilated, leading to poor air quality inside. In the context of ventilation and health, we should consider that all new homes, built to an airtightness of below 10 $m^3/hr/m^2$@50Pa, will be reliant on purpose-provided ventilation. The problem is that many new homes have woefully inadequate ventilation provision, frequently falling short of meeting the minimum requirements of the building regulations. As energy targets push the airtightness further – down to below 5 $m^3/hr/m^2$@50Pa – the health risk both to occupants and the building fabric increases if the property has insufficient ventilation provision. The standard approach to natural ventilation (e.g. trickle ventilators or holes in the wall), may not adequately maintain year-round ventilation: larger inlets/outlets would be needed, and the geometry and volume of a building would need careful design to promote natural air flow. Simply increasing the amount of trickle ventilators, may conflict with the energy performance target of the building, and may impact on the comfort conditions for occupants.

An alternative, and increasingly popular strategy to overcome this problem, is heat recovery ventilation, more commonly abbreviated to HRV or MVHR (mechanical ventilation with heat recovery). With MVHR, fans mechanically supply air into the building, and extract the stale air on a continuous basis. Both the supply and extract fans ventilate at an equal rate meaning that the air coming into and out of the building is balanced. As the incoming fresh air from outside is passed via a heat exchanger, most of the heat energy is transferred from the extract air into the incoming air stream. By doing this, the supply air temperature is significantly increased above the outdoor temperature, thereby reducing the risk

of discomfort, and minimising ventilation heat loss. It's probably no big surprise that passive houses, in cold and moderate climates, require an MVHR strategy to ensure the thermal comfort criteria is met year-round (e.g. fresh air supply must be no lower than 16C). The MVHR market is not limited to the passive house market either: many new-build non-passive house and (non-Enerphit) retrofit homes are using MVHR too, which, in theory is no bad thing. Correctly designed, installed, and commissioned, MVHR systems should provide and maintain good indoor air quality for many years. However, they require more forethought, otherwise they can go wrong, and be a cause for complaints. This article aims to highlight some of the key design and installation considerations to help ensure a successful installation.

Fit for purpose

MVHR systems can only help to maintain comfort conditions if they are fitted in an airtight property. The reason for this is to ensure that as much air as possible, into and out of the building, goes through the heat exchanger. Otherwise what's the point of it?

Heat exchangers in MVHR systems should recover sufficient amounts of heat from the extracted air to make their specification worthwhile in terms of comfort, but also investment. This is known as heat recovery efficiency and is normally stated for almost all systems on today's market, with an increasing amount of them bearing the Passive House Institute certification logo. This means that they have undergone additional tests to confirm that they meet, amongst other things, the minimum heat recovery efficiency requirement of 75%. In fact, many systems today cite recovery efficiency of over 90%. But be careful. Just because the unit states these impressive efficiencies doesn't mean that is what you are going to get. The efficiency of an installed system is a function of the heat exchanger efficiency, the airtightness of both the building envelope and the MVHR system (including ducting), and the correct system air flow setting and balance at commissioning. However efficiency is also affected by the environment in which the system is installed, and therefore the MVHR unit, and all the distribution ducting connected to it (on the warm-side of the heat exchanger), should be installed within the thermal envelope of the building.

On the subject of airtightness, there is often debate about how airtight an envelope needs to be. In passive houses, this is less of an issue as being very airtight (<0.6ach@50Pa) is a requirement of certification. But, elsewhere, air permeability targets vary significantly: for instance, new dwellings in the UK are required to have a maximum permeability of 10 $m^3/hr/m^2$@50Pa (a different unit to ach@50Pa, but for simplicity here we will assume it's the same) if tested. In reality, the design air permeability value can be significantly below this, and is dictated by the values used in the dwelling's SAP (or DEAP) calculation for CO_2 emissions. The final tested value depends on construction type, specification, and build quality. The MVHR supply chain is often not particularly explicit about the airtightness of the properties their products are intended for, after all they do not wish to limit their market reach, and few customers are likely to measure the efficiency to challenge it. Some building designers will say, if the envelope has an airtightness of 5.0 $m^3/hr/m^2$@50Pa or below, then MVHR will be fine. But, if you want to ensure the best performance of the heat recovery, an air permeability below 3 is essential.

Not only should MVHR systems exchange thermal energy as efficiently as possible, they should also be efficient to run. As such, a further criterion for passive house systems is that they have a specific fan power (SFP) of no more than 0.45 Wh/m^3, i.e. for every cubic metre of air it exchanges per hour, it should use no more than 45 Watts of electrical energy. You will find many systems on the market now have much better SFP, often below 0.25 Wh/m^2. But, as with heat recovery efficiency, the actual SFP of a system will depend on the volume air flow, fan performance characteristics, and the total pressure of the connected ducting. For these reasons, and how the systems are controlled, electrical energy consumption throughout the year between systems will vary significantly. As a rough guide, the typical annual electrical energy costs for a well-designed and installed, medium-sized unit used year-round should be in the order of £40-50/yr.

Year-round operation

It may seem obvious that ventilation in buildings is a continuous year-round requirement. So, whilst the efficient operation of a ventilation system is important, it is of even greater importance that it is capable of operation all through the year. Many systems incorporate a summer by-pass facility, such that heat is rejected rather than recovered during warmer periods. But be careful, some cheaper systems simply switch off the supply fan, changing the system into an extract only system. This means that you may need to open windows to get air into the building in summer.

In winter, when windows will most likely be closed, we need to ensure the system is capable of uninterrupted operation. Yet, many MVHR systems on the market are not capable of year-round operation on their own, and will automatically shut down to protect the heat exchanger when the external temperature approaches freezing. This is because the condensation forming on the heat exchanger could be excessive during these conditions, with a further risk that the cold side of the exchanger will freeze, thereby damaging the unit. But, this shutdown could happen at a time when occupant health and comfort is most reliant on good air flow through the system. Designers will need to account for these functional limitations: selecting a unit based upon its volume flow rate capacity is simply not good enough. Ancillary equipment, such as a pre-heater on the incoming air stream is a must where this is not integral to the MVHR unit.

Accommodation & access considerations

MVHR units, their ancillary equipment, and the system ducting can all take up a significant amount of space. In addition to pre-heaters, passive house ancillaries may include a post heater in the supply air distribution for the primary heating for the property. It is imperative that house designers plan for accommodating this equipment in such a way that will encourage the long-term, successful operation of the system, which includes the ease of access for maintenance. If from the outset, the decision is to stick the unit in a loft (particularly a cold one) then think again. Most MVHR system failures relate to poor access, as awkward locations mean that they are difficult to install and commission correctly. And, if access for regular filter changes is too difficult then they also are unlikely to be changed.



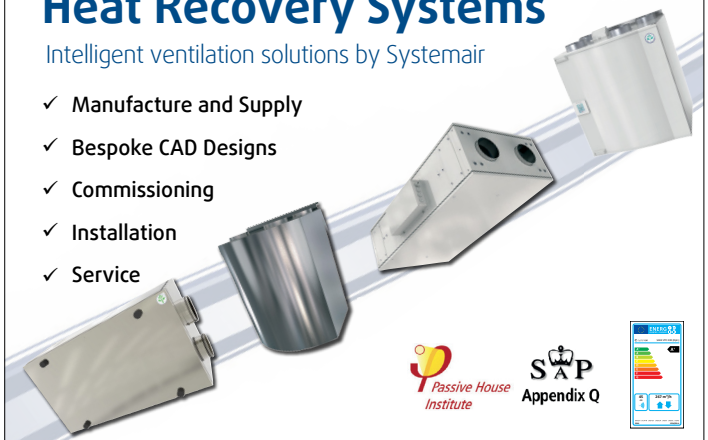
Neat and tidy installation of a Paul heat recovery ventilation system and associated equipment in Larch House, a Bere: Architects-designed passive house. Photo by Alan Clarke.



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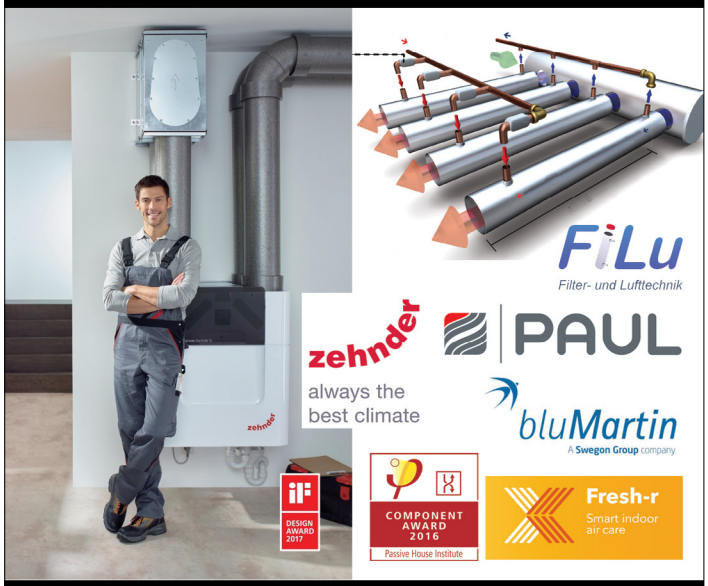
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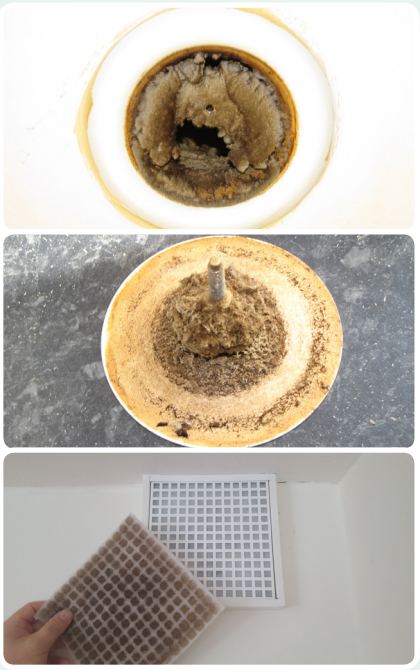
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(top two photos) Examples of heavily contaminated kitchen extract using a valve-type terminal; (bottom photo) Best practice using an extract terminal with a filter cassette

Filters

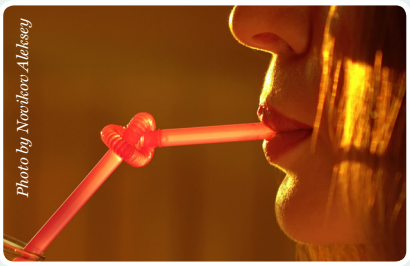
Filter maintenance is a frequent topic with MVHR systems. The primary function of the filters is to protect the system and heat exchanger from dust and particulate matter clogging it up. As a secondary function, this filtration may be of benefit to the occupants, by reducing the number of particulates in the indoor air entering from outside. There is mounting evidence to indicate that occupants living in MVHR-ventilated homes have experienced respiratory-related health improvements. Whilst much of these health improvements are likely due to improved overall ventilation rates, the presence of filters (and the increased airtightness of the building) are likely to have a role, although further research is needed to confirm this.

Different grades of filter are available: general and fine. Fine grade filters, e.g. F7 type for fine particulates, should be used (as required for passive houses) if a greater degree of filtration is desirable. General filters, e.g. G4 for coarse particulates, are normally sufficient for protecting the system. It should be remembered that, the finer the filter, the greater the resistance on the system, and the more regular the maintenance may need to be. If filter maintenance is not routine, then the performance of the system will soon be compromised. Subject to location, you will need to plan for at least twice annual changing, or every quarter. If this degree of maintenance cannot be factored in then MVHR may not be an appropriate strategy for your project. This is often debated in the context of social and private rental properties where programmed maintenance is usually limited to annual gas safe checks. It is also worth pointing out that costs for filter replacement, per year, can be greater than the electrical running costs of the system.

A final note on filters: most installations that I see tend to use extract air valves throughout the wet rooms in the house, including the kitchen. However, if we want to protect the ducting and the heat exchanger with filters in the machine, why not extend this principle to the kitchen? Grease from cooking can enter the ducting and make it easier for dust and other contaminants to cling to it and compromise the performance of system. It is always best to use a filtered extract terminal in the kitchen, which usually employ a simple (cheap) fleece filter to prevent kitchen grease entering the ducting system.

Air distribution

MVHR systems usually distribute air to and from the occupied areas of the building via a network of ducts that terminate in ceiling or wall mounted grilles or valves. This system of ducting, plus the terminals and the filters, will add a certain amount of pressure at any given flow rate. There are a few terms for this, including: total pressure; system pressure; external pressure; static pressure (albeit incorrectly used here); and system resistance. Whenever I talk about the relationship between volume air flow and the resulting pressure to students, I quickly see them glazing over! The reality is that we understood these basic physics when we were young children. Anyone who has ever had a fruity or ice slush milkshake will remember that, when a large bit of fruit pulp or slush enters the straw, the pressure in the straw increases, and you needed to apply more power (suck harder and turn pink) to increase the flow rate of the milkshake - especially if you use a bendy straw! It is exactly the same principle with ventilation ducting systems: the greater the system pressure, the greater the fan power to move the required volume of air. In any ventilation system, but especially so for MVHR (which tends to have the greatest amount of system ducting compared to other types), it is imperative that the system pressure is calculated when designing the ductwork for both the intake air/supply air side and the exhaust air/extract air side. Otherwise, you will not be able to select the right capacity MVHR unit to deliver the air flow that you need.



Just like with a kinked straw, MVHR systems need to apply more pressure to move air through through bendy ductwork, so it is imperative the system pressure is calculated at the outset in order to select the right capacity of MVHR system.

Ducting is usually the weakest link in any ventilation system, and is often the primary cause of poor performance. But with a little forethought, it isn't difficult to get right. It takes on many forms, but selecting the right design, size and type will be central to the success of the system. Further information about ducting types is given in the boxout section.

To ensure good air distribution in each room, it is important both to select, and to locate air distribution valves correctly. Get this crucial bit wrong, and you may end up with poor air circulation in rooms, or air velocity discomfort. It is always important to check the air distribution characteristics when specifying air distribution products. But as a general principle, ceiling mounted supply air diffuser valves are best placed central to the room, as this gives greatest flexibility for floor layouts. For example, a bed in a bedroom is rarely in the centre of the room, and you should always aim to avoid air distribution directly over a bedhead. Make sure that, if you have no other option than to locate a supply valve near to a wall or corner, you fit blanking sections inside the valve (nearest the wall) to minimise the potential for vertical air velocity discomfort down the wall.

Extract air valves in wet rooms should ideally be placed on the ceiling, but if you need to wall mount, you should aim to mount the valve within 400mm from the ceiling to maximise the efficacy of moisture removal. In addition to room valves, the pathway between supply and extract air flows needs to be included in any design. Most commonly, MVHR systems rely on the "cascade effect", to ventilate circulation areas. This is where air moves from supply to extract points through the building, thus avoiding the need, usually, for supply air points in hallways, landings, etc. To do this air transfer between all ventilated rooms is essential, and this is normally done by providing a 10mm undercut beneath internal doors, although the exact amount can be calculated according to the designed air transfer rates.

System capacity

The chart shows an example of the fan performance characteristics, or fan curves, for a typical MVHR unit. It is imperative that the chart specific to the unit proposed for a project is closely examined to ensure fitness for purpose for meeting designed flow rates. You will now see why it essential to have access to the designed system pressure: you will not be able to select the right sized unit otherwise. In theory, the unit in this example has the capacity to move some 350 cubic metres per hour (m^3/h) at 0 Pa system pressure (i.e. zero resistance – isolated from a duct system) whilst operating at 100% maximum speed setting. However, depending on the duct design, system pressure could be between 50 and 150 Pa under normal operation. Assuming 100 Pa, and a normal operation flow rate of 200 m^3/h, the chart shows that the system will be operating at around 75% of its

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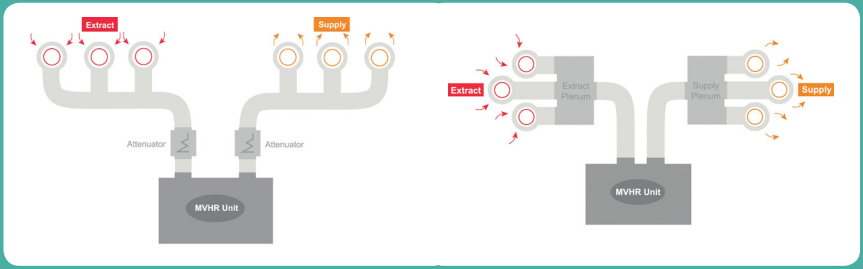
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The two main types of MVHR duct distribution system — branch (left) and radial (right).

Ducting comes in many forms: steel, aluminium, plastic; rigid, semi-rigid, and flexible; round, rectangular, oval, and so on. The wide range of choices may seem overwhelming. Let's get one thing out of the way first: do not use flexible ducting under any circumstances. If you really need flexibility, then use semi-rigid ducting with smooth internal surfaces, and only use gentle bends. Avoid rectangular ducting if possible, particularly for supply air where the duct is under positive pressure: the air flow characteristics under this condition are much better with circular or oval ducting. The choice of material mostly comes down to project budget. Rigid steel ducting is the most robust, and therefore, easier to clean. It should also last for a long time (30+ years), but this added benefit will increase the initial capital outlay. Whether metal or plastic, always use proprietary connectors, bends, tee pieces, etc. Make sure all connections have an airtight seal, and are mechanically connected. And always use ducting where the air flow performance data is available: avoid "bespoke" ducting.

There are two main ducting configurations to choose from for the air distribution to and from each room: the branch and radial systems. With the branch system, the main branches reduce as each room branches off. Radial systems are increasingly common, where the main supply and extract ducts from the MVHR unit terminate in plenum boxes from which, each room is ducted separately.

There are advantages and disadvantages with each type, although some MVHR suppliers are now beginning to widely promote the radial system. However, there are a few things to consider before settling on the most appropriate solution – any one approach may not suit every installation. Also, there is nothing wrong with a hybrid approach: anything is possible provided it is properly designed, and can be accommodated within the building.

Some key points to consider for each type.

FOR BRANCH:

- This approach has lower turbulent characteristics as branches are engineered to allow smoother air flow, compared with plenum systems;
- Branch systems require greater amounts of larger diameter ducting, minimum 100mm diameter, with the main branch up to around 160mm diameter, which may cause accommodation problems, particularly when run through intermediate floors;
- Balancing of the air flow in the rooms via adjusting room valve grilles relies on good duct design to ensure local velocity (hence noise) is not too high for the required flow rate;
- Additional sound attenuation may be necessary, particularly for metal ducting;
- With branch systems there are likely to be more ducting connections, bends, and tees (compared with semi-rigid, radial), and possibly higher risk of air leakage, depending upon ducting quality.

FOR RADIAL:

- These systems can be easier to install as radial ducts between plenum (or manifold) and the room allow for smaller diameter (typically 75mm), and are more forgiving to the use of semi-rigid ducts. However, higher flow rate rooms (e.g. kitchens and large rooms) may require two radial duct runs to each terminal grille;
- Less sound attenuation is needed: cross-talk silencers can be omitted;
- A potential downside is that you need to find additional space for the supply and extract plenum boxes. These should be placed centrally in the property (not the loft, unless single storey) to minimise radial lengths;
- Use good quality plenum boxes, as poor designs can cause significant air leakage;
- Radial systems can be fiddly to commission as each radial run needs adjustment via supplied flow restrictors or dampers, and can take a while to set up correctly.

INSULATION

It is important that ducts are insulated – where necessary – to minimise heat losses through the system, and to reduce risk of condensation. Assuming the MVHR unit is installed inside the thermal envelope, then the intake and exhaust ducts on the cold side of the heat exchanger will need to be insulated. Condensation occurrence on these ducts will be on the outside of the duct, so insulation must be vapour resistant. Distribution ducts on the warm side of the heat exchanger do not necessarily need insulating, unless: a) they pass through an unheated area (e.g. a cold loft), in which case they need to be fully insulated to prevent condensation occurrence, which will occur on the inside of the duct (insulation need not be vapour resistant, although it is still good practice), or: b) the supply air distribution includes post-heating, (e.g. some passive houses) where vapour resistant insulation would be required.

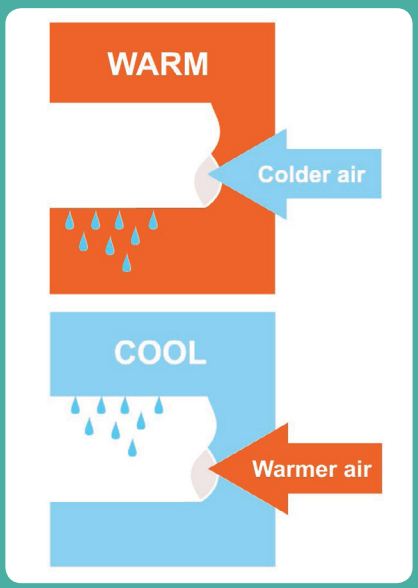
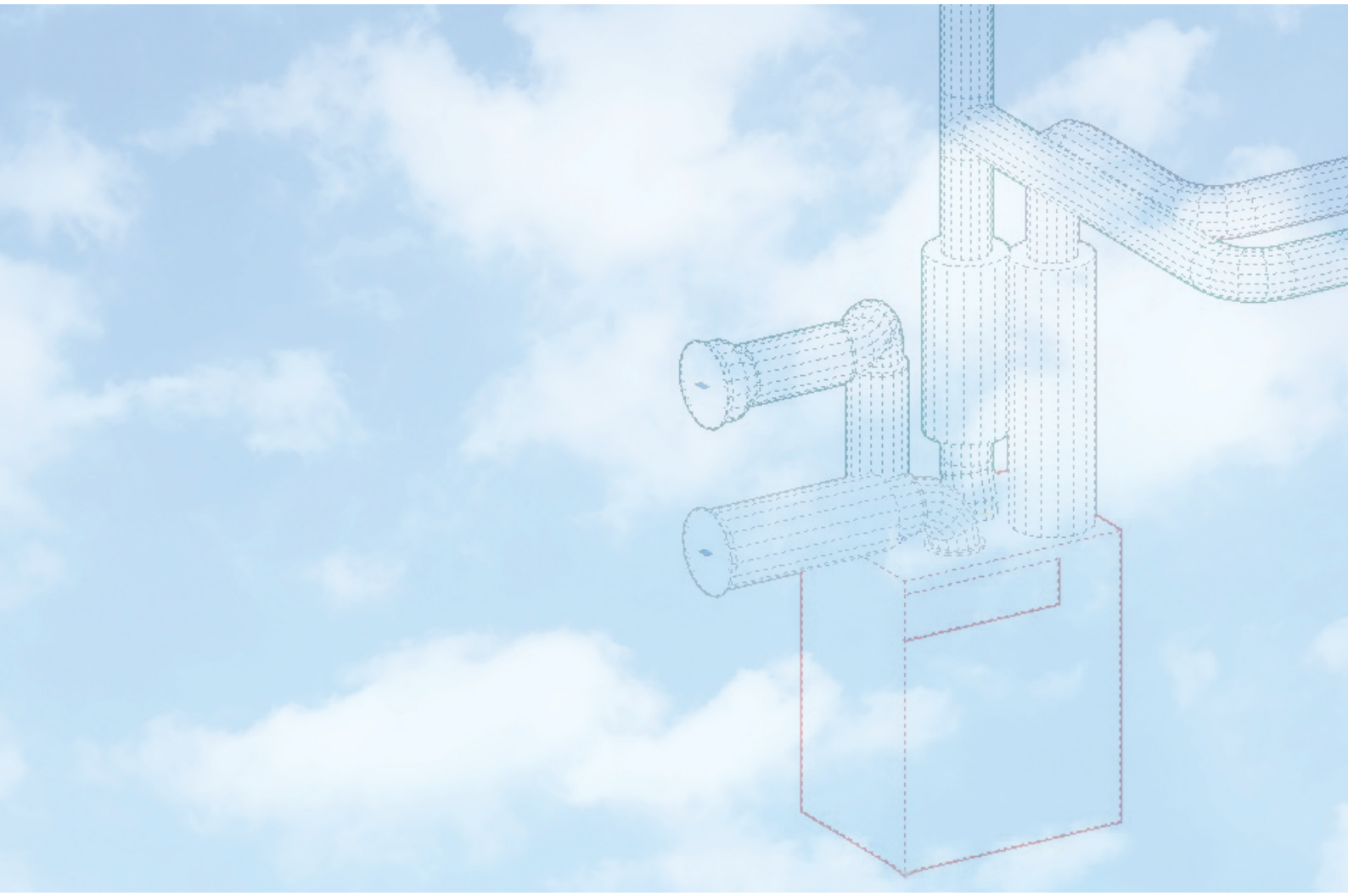


Diagram illustrating potential ways in which condensation can occur in heat recovery ventilation systems.

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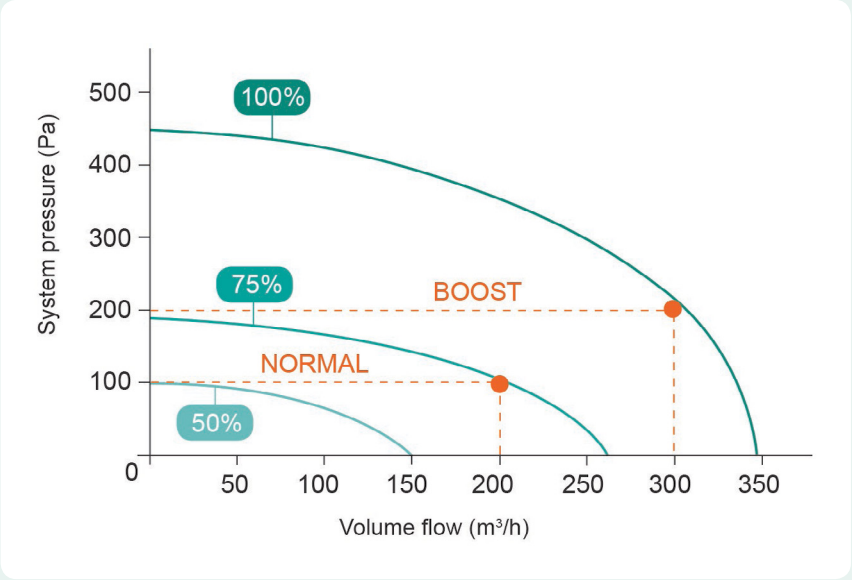
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This chart demonstrates how an MVHR system can perform at between 50% and 100% of its capacity depending on the air flow rate and the system pressure.

capacity. The higher setting for boost at 300 m³/h could increase the system pressure to around 200 Pa, but now the fans are operating around 95% capacity. Now there's nothing particularly "wrong" with selecting this unit for this situation – it meets the capacity needs. But this capacity is based upon meeting minimum design requirements (i.e. complying with Building Regulations). In reality, this capacity may underestimate the real needs of the building. For example, how much influence will the number of occupants, occupant density, activity, and moisture generation have on the ventilation needs? The point here, is never aim a design just to meet the minimum volume flow, as you may not have extra capacity should it be required. It is also important to recognise that the closer to the maximum curve you get, the more electrical energy the system will need to meet the design performance. Good practice would be to select a unit that has greater capacity, and, this is my rule, where the normal (lower speed) design flow rates can be met by no more than 60% of the available capacity, and high (or boost) design setting is met by no more than 80% of the capacity.

When sizing and selecting a unit, it is also important to consider fan control. Many lower-to-mid priced units simply run the variable speed fans at the setting selected during commissioning. However, it won't take long for the motor bearings to bed-in, and filters to become increasingly soiled, which will progressively reduce the air flow. It is best to specify systems that have constant volume flow control, such that the fans automatically regulate the fan speeds to maintain the commissioned volume air flow when the system pressure increases. If you specify a system without this degree of control then you will need to make sure that you have greater capacity from the outset. The system will need to be commissioned at flow rates above the design values to factor the potential for reduced performance.

System noise

Noise potential can be very significant and is often overlooked during the design and installation phases. Noise is the number one reason many poor-performing systems are switched off by disgruntled occupants! Good design practice would be to locate MVHR units away from sleeping areas: another reason not to stick the units in the loft. It is best to avoid cupboards leading off bedrooms too – another common location. Noise can be minimised by sizing a larger system to operate at lower speed, thereby reducing the motor noise. But noise relating to MVHR systems isn't just about mechanical fan noise. "Whistle" noise due to localised air velocity is a significant cause for noise complaints, and this can be associated either with: poor design of ducting (under-sized); poor installation (e.g. sharp edges and bends); or poor commissioning (e.g. incorrect valve settings in rooms). Good ducting design will usually include sound attenuation to reduce system noise, and, if a branch system passes ducting runs between rooms then – especially for metal ducting – you may need attenuators to improve privacy. Vibration from MVHR units can be a further nuisance, and can occur if the unit is poorly mounted, or if the ducting poorly installed. Wherever possible install a unit on a solid wall or floor and, use anti-vibration mounts (often supplied as an optional extra).

System commissioning and use

All MVHR systems require a degree of commissioning. The aim of the commissioning is to ensure that the system is set up correctly to deliver the design air flows as efficiently as possible, and that the intake/supply air streams are balanced with the extract/exhaust air streams. Achieving a perfect balance in reality is not easy to do, and so as long as the imbalance is less than 10% (mandatory for passive houses) then that will be fine. Most well-designed and installed systems that I commission tend to have an imbalance of <3% when done. Commissioning any ducted system will require good knowledge of the design and installation so that limitations that might affect the commissioning process are known. This almost always means setting the fan speeds for the supply and extract fans separately to account for the different system pressures on each side. Often the supply fan will need to work harder than the extract as there tends to be more ducting and outlets on the supply side (more pressure) compared to the extract that only deals with wet rooms. Rarely have I commissioned any system and not had to change the manufacturer's default balance settings, even if they claim to automatically balance.

The air flows – through the system and in each room – need to be measured using a calibrated volume air flow meter, so commissioning is a usually a job for a specialist. It is important to bear in mind that, since 2010, ventilation systems are a controlled service in the UK, and therefore evidence of correct commissioning of an MVHR system is notifiable under the Building Regulations (Part F for England and Wales; Part K for Northern Ireland) and should be submitted to the building control body. Evidence of final commissioning is also required for passive house certification.

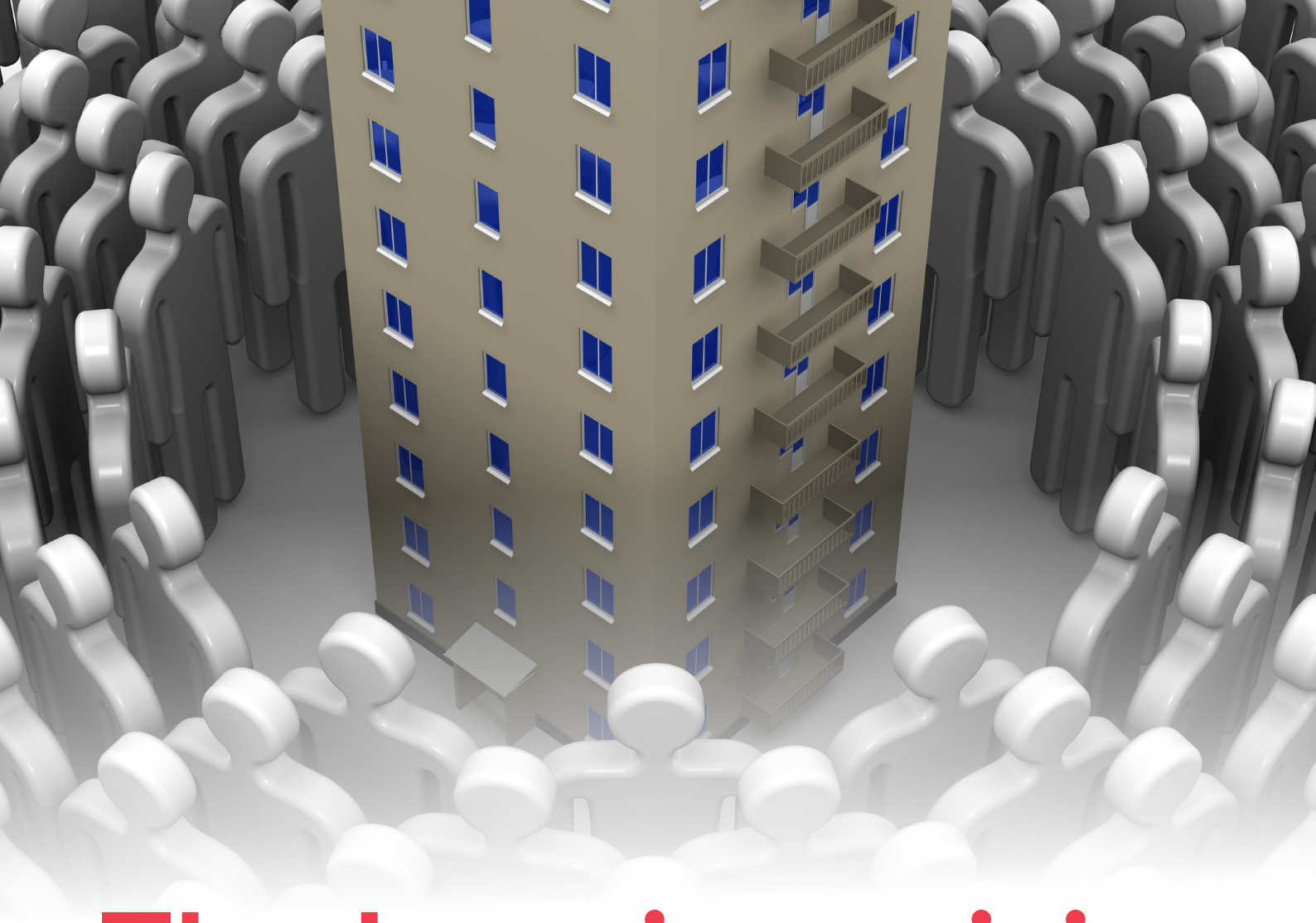
MVHR systems come with some form of manual, automatic, or demand control. In many cases, occupants tend not to interact with their system too much, and, in my experience, end users will seek out the controller only if they have a problem – usually noise, air velocity discomfort, or perceived high running costs. If you do provide manual controls, then make sure they are simple to understand, and accessible (not stuck away in a cupboard). Automatic control of fans, e.g. humidity-based, should not lead to sharp increase in noise levels. The best MVHR system is one that you don't know is there: it is quietly and efficiently ventilating the home for the comfort of the people inside. It is possible, believe me. ■

Next issue...

The PH+ guide to:

air-to-water heat pumps

The next issue of Passive House Plus will include our guide to air-to-water heat pumps, including practical advice on the issues to address to ensure the system you choose is as light as possible on both your pocket and on the planet, without compromising on comfort.



The housing crisis

what is to be done?

Almost a decade after the economic crash, every political party in Ireland now recognises the country is in the middle of a full-blown housing crisis. Similar problems exist in the UK market, but for different reasons. Now, if the political will to fix things has finally arrived, the question remains — what can actually be done about it?

by Jason Walsh

Ireland's housing crisis has been making headlines this year, whether due to the deaths of homeless street sleepers or the growing sense that not only is home ownership an impossible dream, but that even private rentals are thin on the ground.

Even Ireland's political class, buoyed for decades by rising house prices as an index of wealth, is finally sitting up and taking notice.

Taoiseach Leo Varadkar recently mooted doing away with Dublin's height restrictions to allow for high-rise development, as well as, controversially, a return of the late, unlamented bedsit.

"There is a housing crisis in Ireland, and while you are in a crisis situation you approve policies and do things that you wouldn't do if there was not a crisis," he said.

Housing minister Eoghan Murphy has said that this year Ireland will build quadruple the number of social housing units that were built in 2015, but with more than 90,000 people on the housing waiting list it is hard to see how even that – or the pledged 3,800 new houses next year – will make a dent.

As Irish Times commentator Fintan O'Toole recently noted, by 2015 only one per cent of GDP was spent on public housing. Meanwhile, 21 designated 'rent pressure zones' have been created in order to cap rent rises in the private sector.

It seems an absurd situation: during the boom years it looked as though the entire Irish economy was based almost solely on building houses, and yet today completions are at a low, causing prices to rocket.

According to figures compiled by economist Ronan Lyons for property website Daft.ie, average prices in Dublin have risen by 60 per

cent since 2012. Meanwhile, according to figures from the Real Estate Alliance Average House Price Index, a three-bed semi-detached house in Dublin now costs over €400,000.

The private rental market is also notoriously overheated, with high prices and severe shortage of units. The average monthly rental on a one-bedroom apartment is now €1,422 in the city centre, and €1,145 further out. A three-bedroom apartment in the city, meanwhile, will cost you €2,544 per month.

And that is assuming you can find one. Or that it meets even minimum standards for habitation.

According to Dr Lorcan Sirr, lecturer in housing at the Dublin Institute of Technology, the seeds of the current crisis were sown not during the boom years, but as far back as the 1980s.

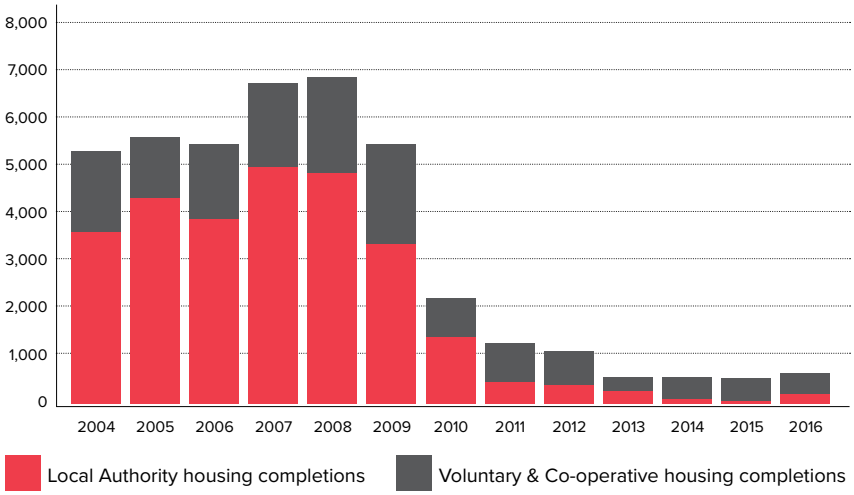
"That was the sea change," he said. "The change of the funding model from local authorities borrowing [in order to build] to getting central government grants."

This change in funding model accentuated the housing boom to come, he says, and did so by cutting away at the social housing security net.

Sirr does see potential for improvement, however, precisely because the problem is now so bad that it is recognised across the political spectrum.

"Never mind social housing, you have an affordability issue, and that's hitting the traditional Fine Gael voter and their sons and daughters. It's not an issue just for poor people. The people who would have voted Fine Gael and Fianna Fáil before now have more in common with people who would be far to the left of them,' he said.

Irish new build social housing







(top to bottom) Graph showing the decline of new social housing construction in Ireland between 2004 and 2016; longstanding O Cualann member Aisling Lynch breaking ground at the group's new development of co-operative housing in Ballymun, Dublin; finished homes at the development, which consists of a mix of two, three and four-bed terrace units, built in three phases.

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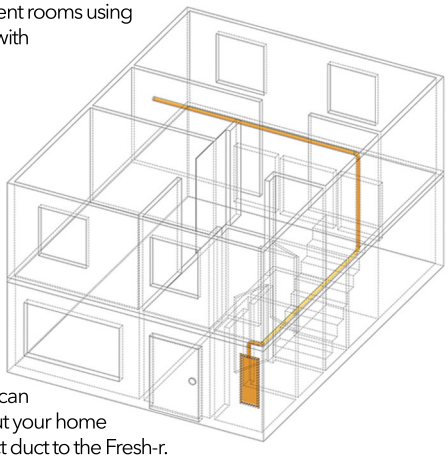
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A map from the Woodbrook-Shanganagh Local Area Plan, where Dun Laoghaire-Rathdown plans to build 540 units alongside 1,000 privately developed homes.

As a result, the political reality is that everyone is saying something must be done but no-one is quite sure what.

Sirr says that the banks will have to get on board and change their model, otherwise they will have no customers in coming decades.

"The banks are a huge part of the problem and will be a huge part of the solution. Their mortgage business will collapse if things keep going this way," he said.

One recent idea floated by the government has been the transformation of Ireland's 'bad bank' Nama into an agency to develop housing. Certainly, Nama, a legacy of the 2008 crash, has major land assets, so handing this land over to local authorities to develop social and affordable housing can't hurt. At the very least it recognises that land banking is a major problem – and one of the primary causes of Ireland's housing crisis.

For instance, one developer alone, Cairn Homes, controls around twenty per cent of the zoned, un-used land in and around Dublin. Cairn is not alone, of course, but many developers like it complain that they cannot profit from building while sitting on land left unused.

Last year's housing completions totalled 15,000 nationwide, but, in fact, only 5,000 new homes were built, with the rest being reconnections to the grid of vacant properties. This over-counting is a major issue when it comes to getting to grips with the depth of the housing crisis.

"Between 2011 and 2016 we only added 8,800 [dwellings] to our stock, and, at the same time our population increased by 170,000," said Lorcan Sirr.

Some more concrete moves have been made, however. One is a new model for development proposed by Ó Cualann Cohousing Alliance.

Founded in 2014 by Hugh Brennan and Bill Black, Ó Cualann intends to create what it calls fully-integrated, co-operative, affordable, sustainable communities – and unlike many plans, Ó Cualann's work is not purely theoretical.

Brennan explains that Ó Cualann has already developed housing in Poppintree, Ballymun, in association with Dublin City Council.

The development, which consists of a mix of two-, three- and four-bed terraces in three phases, was able to go ahead because of the council's commitment to lowering the cost of land – the single greatest cost problem in housing in Ireland today.

"We worked with the support of Dublin City Council. Dublin City Council has a lot of land in areas where there is more social than owner occupiers and they're trying to re-adjust that balance," he said.

"Our vision is for 60–70 per cent owner occupied, and among the remaining 30–40 per cent, which are rented, a third would be private affordable, a third social rental and third elderly or disabled. [Though] That's not set in stone, its fluid," said Brennan.

Getting this mix right is key, says Brennan, because ownership is an important factor in developing communities, but so-called "affordable housing" is itself unaffordable.

Average prices in Poppintree were between €170,000 and €177,000, whereas the likely market price would have been over €260,000.

"They're located 7.5 kilometres from the city centre, you can cycle in; they're near schools and Dublin City University; there are buses, there will be the metro, you're minutes from the M50 and the airport – and there are 2,000 plots available in Ballymun," he said.

Brennan is clearly convinced the development has worked, but the question is can it be rolled-out on a larger scale.

Ó Cualann pays €1,000 per plot, plus VAT. The typical value of a plot is around €20,000, so it is clearly a model that can only work if councils, which own the land, are more concerned about solving the housing crisis in their midst than in making super-profits.

Brennan says, however, that this is increasingly the case, and that more and more local authorities are taking an interest in the model itself, particularly as a form of regeneration and because a 'clawback clause' means that profiteering via house-flipping can be eliminated.

"We're talking to Fingal, [and] they're supportive; likewise Limerick, and we've talked to Waterford. We hope it can be replicated and scaled; we hope that other people can take up the model, rather than just doing projects [with us]. That's our objective."

In the case of Ballymun, Brennan calculates that the development could introduce as much as €13m into the local economy annually.

"If all of those 2,000 sites [in Ballymun] were brought in the multiplier effect would be tremendous. That's capitalism at work," he said.

For Brennan the idea is a mixture of co-operation and capitalism: "I've a vested interest in this: I've four children, whom I want to be able to afford a house. Won't we be better off if we create social capital rather than financial?" he said.

On a national level, primary legislation may be required, however, to lay the groundwork for large scale development on council land.

Ossian Smyth, Green Party councillor for Dún Laoghaire, says local authorities are interested – and more than aware of the problem.

"There's a county development plan. Every local authority has to do that and you plan out in that how many homes you have to build. Our plan is 31,000 houses for 70,000 people, from 2016 to 2022, based on the regional planning guidelines," he said.

"We have to make sure that we've zoned enough land and have enough density, plus have enough schools and transport."

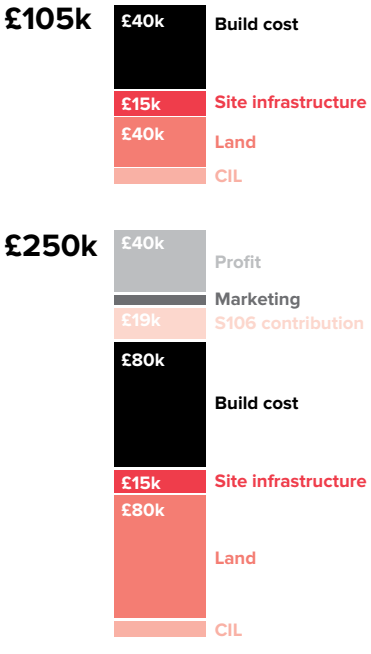
Dún Laoghaire-Rathdown County Council itself plans to build 540 houses on its own land in Shanganagh, beside a planned private development of 1,000 houses.

"[Then environment and housing minister] Simon Coveney told us we could have any money we wanted, when he was running for Taoiseach. He said he wasn't being asked for enough money. The signs are central government is gearing-up to fund more building," he said. The problem of land banking remains, however.

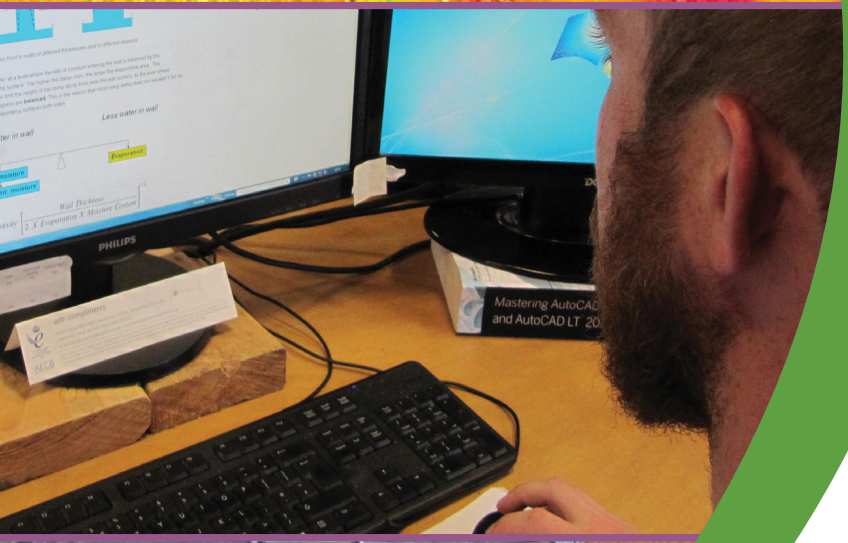
"The political debates and ideological debates are kind of over because everyone has realised the private developers are holding back. Land hoarding is going on, so our only option is land we already own and compulsory purchase."

"All sides want to do something about it from a human point of view," he said.

(below) Writing on Medium.com, Alastair Parvin of the Wikihouse Foundation proposed, if some development land could only be bought, owned and developed by the people who live there, it could drastically reduce the price of land and cut the cost of building a house from £250,000 to £105,000.









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A VERY BRITISH HOUSING CRISIS

In September 2017, a letter published in a British newspaper became an unexpected internet meme, passed around because of its shocking content.

The letter, written by one John Searle of Grantham, noted that when he earned £1,000 a year working as a fireman he bought a house valued at £3,500. Today, that same "very ordinary" house is now valued at £650,000 and a mortgage for it would require a deposit of £50,000 and a household income of £200,000.

This alarming anecdote is backed-up by the cold hard numbers: £650,000 may not be the average, but the typical figure is no less unaffordable.

Official British government statistics indicate the average house price in the UK was £223,257 in August 2017. This figure, of course, downplays regional variations.

In England, an annual price increase of 5.2 per cent has taken the average property value to £240,325. Monthly house prices have risen by 0.8 per cent since May 2017. In London, meanwhile, an annual price increase of 2.9 per cent took the average property value to £481,556.

Overall, income share spent on housing has trebled in the last fifty years, and housing in or near the centre of the capital is now so expensive that developers have resorted to building tiny "micro homes" in order to meet demand from young professionals.

Meanwhile, a September 2017 report published by the think tank Development Economics said London risks becoming a "ghost town". Speaking about the report, which advocated smaller dwellings, the think tank's Stephen Lucas said: "With greater numbers of people than ever choosing location over space when deciding where to live, building sufficient quantities of high-quality, centrally located housing will be essential for London's future economic, social and cultural growth."

It should be noted, however, that Britain is already home to the smallest dwellings in Europe, with an average floor space of 76 square metres. The Irish average is 87.7, while Germany averages 109.2, France 112.8 and Denmark 137.

Even the government has declared Britain's housing market "broken". Speaking to parliament, communities and local government secretary Sajid Javid, noted average house prices had jumped to 7.5 times average incomes and rents in many places swallowed more than half of take-home pay.

Describing the prospect of home ownership as a "distant dream" for young families, Javid said: "We have to build more, of the right homes in the right places, and we have to start right now."

Dr James Heartfield, author of the book "Let's Build!: Why We Need Five Million New Homes in the Next 10 Years", says that prices are driven by the coincidence of both a shortage of units and the amount of credit in the market in previous years.

Heartfield says that as a result of these two phenomena the economics of the UK's property market have taken on a somewhat fantastical dimension.

"It's kind of deceptive," he said. "Lots of people have properties that are worth vast amounts, but then they also have massive mortgages on these properties. So, while people do have a lot of capital, you can't ever realise this capital. It's such an over-inflated market."

Heartfield wrote "Let's Build" in 2006, and in the decade that followed five million homes were not built. Despite hitting a seven year high in 2015–6, average figures peaked at just 164,000 per annum. Since then, there has also been the 2008 financial crisis, which only worsened things: in 2012–13 the county hit a post-war low, building just 135,500 homes.

The pre-recession peak was 200,000 per annum. Only twice has UK housebuilding reached 350,000: once in the mid-1930s, and again in the late 1960s.

According to Heartfield, both the left and right recognise the problem, but, as yet, have not developed anything like a detailed plan to deal with it.

"I think it's a real disaster in terms of political will. I've met Jeremy Corbyn – and pressed my book into his hand – and talked to him about the problem; we've [also] seen commentators like Owen Jones and Polly Toynbee who want to reverse Labour's historic objection to new builds," he said.

Of course, Labour and the Tories naturally favour different solutions. A further stumbling block is the current Conservative government's weak mandate, and the fact that Brexit is taking up much of the country's politics.

"Their belief that you could fix it by council house building is interesting, but we'd need to see more detail," said Heartfield.

"On the Tory side, formally they're committed to doing more as well, but at the moment they're snarled up in the hiatus of Brexit – and they're badly behind in the polls. In both parties the front benches are formally committed to building more homes, but it's unlikely that we'll see it happen," he said.

For Heartfield, the real tragedy is that nothing that has happened was unexpected.

"This was all utterly predictable. I can say that because we did, not just me, but also [his colleague, architect] Ian Abley, as well as [Bank of England economist] Kate Barker, who was shot down in flames for saying this," he said.

Of course, despite being the area of highest pressure, the south east of England is not alone.

A recent report published by Shelter Scotland found that between April 2016 and March 2017 more than 21,000 individuals in Scotland made use of Shelter's services – and not just those traditionally viewed as homeless.

The three most common problems were "struggling to pay or afford housing costs" (15 per cent), "housing conditions" (12 per cent), and "landlord issues" (10 per cent), while affordability was the main issue for private renters, social renters and homeowners alike.

Innovative ideas

Clearly, a new policy approach will be required, but in the meantime some innovative ideas are on offer.

Writing on medium.com, Alastair Parvin of the WikiHouse Foundation has proposed what he calls "housing without debt", which is effectively a call for the creation of a parallel market in land intended to reduce capital expenditure in housing development.

Working on the basis that land zoned for development is worth many times what agricultural land sells for, Parvin proposes that some land could be zoned so that it can only be bought, owned and developed by the people who live there. This would not only allow for cheaper development, but do nothing to stop the buying and selling of homes, so long as those homes were owner-occupied.

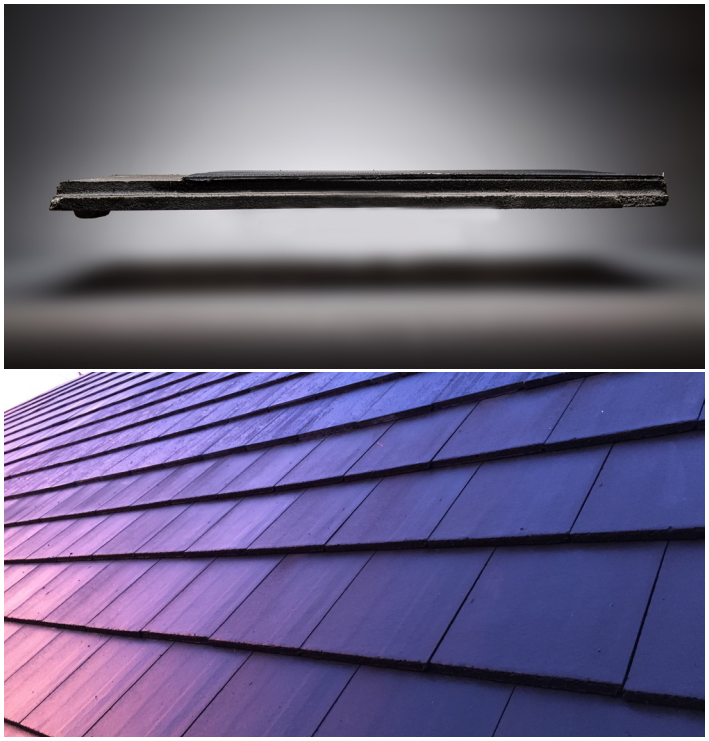
Parvin calculates that this could reduce the cost of building a house from £250,000 to £105,000, and, he says, the legal mechanisms already exist to allow for it in the form of the Self & Custom Building Act, the existence of Community Land Trusts and the simple matter of legislative provision for dwellings procured and owned by their occupants.

Like the Ó Cualann schemes in Ireland, it is unlikely to solve the housing shortage on its own, but then again, it isn't intended to. What it could do, however, is dramatically lower the cost of entry to the housing market, particularly when twinned with peer-to-peer and mutualised financing. Bear in mind that building societies were initially developed to do just that – to build – and that 'permanent' building societies were a later development.

In the meantime, as pressure continues to increase on the housing market, any solution other than overcrowding is a welcome development. ■

Marketplace

Solecco Solar launches new solar roof tiles



(above) Solecco solar roof tiles.

Solecco Solar launched its innovative solar roof tile solution at the UK Construction Week trade show which took place on 10 to 12 October at the NEC in Birmingham. The company also launched its new website www.soleccosolar.com at the annual industry event.

The new technology company supplies and installs "unique, sustainable roof tiles for developers and homeowners with aesthetics and renewable energy at the top of their design agenda". Manufactured in Leeds, the 19mm tiles come with a competitive 17.9% efficiency. The solution is integrated into roofing via a unique interlocking method, with tiles fitting flush and seamlessly on up to 98% of roof surface area. Solecco Solar said that the zero-glass system has "an impressively low carbon footprint and is an eco-asset which drives energy efficiency and protects against rising electricity costs". Solecco director James Birch told Passive House Plus that speed of construction and an associated reduction in labour costs was another major advantage of the new system. According to Birch, an 8.425 kW system can be installed in four hours – just half an hour longer than a conventional roof.

The UK Construction Week event took place on 10 - 12 October at NEC Birmingham, with Solecco exhibiting in the Energy 2017 show alongside other energy saving, power management and renewables companies. The company's stand featured a pop-up roof to display the unique solar roof tiles – available in slate grey and natural terracotta.

Solecco is shortlisted for product of the year award at both the London Construction Awards and National Energy Efficiency Awards 2017. ■

Good design can eliminate noise issues with MVHR — CVC Direct

Leading MVHR (mechanical ventilation with heat recovery) supplier CVC Direct has emphasised the importance of good design in preventing noise issues with ventilation systems.

"We are often asked how noisy our MVHR units are — in order to answer this question, we need to explain what are the causes of noise in ventilation systems," Nicholas Vaisey of CVC Direct told Passive House Plus.

"It is important to look at a complete MVHR system, not just the MVHR unit. Good duct design and specification play a huge part in the operating efficiency and noise levels of an MVHR system."

"Higher specification units have constant volume fans (as opposed to constant speed fans) which operate by constantly assessing the system pressure and adjusting the fan to maintain the commissioned airflow."

Vaisey explained that a poorly designed duct network adds to the system pressure and in turn prompts the unit to run at a higher speed in order to maintain flow, thus making it noisier and increasing energy usage. A well-designed system, on the other hand, allows the MVHR fans to run at the lowest speed necessary to maintain the desired airflow, resulting in quiet, low energy systems.

"It is important to size the duct appropriately, relatively large volumes of air are being moved through the system and using a larger duct may be used to keep in-duct air velocities lower. Forcing too much air down a small duct means high velocities and increased noise. Unnecessary bends, sharp bends and corrugated ducting also result in increased duct pressures in the MVHR system, which, in turn, increases the noise from the unit and the turbulent airflow."

Vaisey said that if a branched ducting system is not designed correctly with appropriately placed attenuation, sound can be transferred between rooms – this is known as cross talk. A correctly specified radial ducting system with a smooth inner core and manifold for air distribution air reduces system pressure and prevents cross talk issues.



Neat & tidy installation of MVHR radial ducting by one of CVC Direct's self-build customers.

He continued: "It is also important that the unit be maintained. Filters must be cleaned regularly as dirty filters will result in increased resistance to airflow. This causes fans to run faster, which again will lead to increased unit noise.

"Finally it is important to choose an appropriately sized unit for the property; an undersized unit will have to work harder to provide adequate airflow." ■

New passive show home built with Kingspan TEK



(above and inset) The Elsworth show home, built with Kingspan TEK structural insulated panels. Photo: courtesy of Potton.

The Kingspan TEK building system of structural insulated panels (SIPs) has been used to create an ambitious show home delivering passive house performance.

HTA Design's blueprint for the new Elsworth show home centres around a small enclosed courtyard with a large rooflight to maximise natural light. This is surrounded by living areas whose size and purpose can be adapted to suit different lifestyles.

Architect and head of sustainable future at HTA Design, Rory Bergin, described the project: "Achieving the requirements of the passive house standard can be a challenge. It often leads the architectural design of the building to be compromised in order to offer the most energy efficient form, typically resulting in a design that sacrifices interest for simplicity.

"Potton and HTA Design wanted to demonstrate that this is not necessary when a high-performance construction system is used. We purposely selected the design which would be the most complex to build from an energy efficiency perspective as it offered the most flexible family home. The result is a testament to the high levels of building performance and architectural design that can be achieved with careful planning, expert workmanship, and the right products."

The build features the Kingspan TEK building system panels in both 142mm and 172mm widths. The 142mm panels were used to form the walls, with an additional external layer of 100mm Kingspan Kooltherm K12 framing board to ensure a 'thermal bridge free construction' and to achieve a U-value of just 0.10 W/m^2K. The roof was constructed with 172mm panels as the increased thickness allows the panel to span further without additional support. The OSB/3 facing of the panels and unique jointing system also helped to achieve air leakage rates of 0.43 air changes per hour at 50 Pascals.

All Kingspan TEK panels manufactured at the Sherburn–in–Elmet manufacturing facility are certified to BES 6001 'very good' and the manufacturing facility also carries both FSC and PEFC chain of custody certification. ■

Viessmann named best buy boiler brand by 'Which?' magazine

Viessmann has been named as a Best Buy gas boiler brand by 'Which?', the UK's largest consumer organisation. As one of only two gas boiler manufacturers to be recommended in this way, Viessmann is praised as "the most reliable" of all brands and "well-liked by owners and respected by the professionals too."

This glowing assessment is the result of a survey conducted earlier this year which questioned 9,610 boiler owners and 219 heating engineers throughout the UK. The survey sought the views and experiences of consumers who actually own the boilers and obtained from engineers an in-depth picture of build-quality, availability of parts and spares, ease of repairing and servicing, and how likely they are to recommend a boiler from each brand.

Viessmann achieved a score of five stars for brand reliability and customer satisfaction, and four stars for build quality. Viessmann's overall brand score — based on reliability, customers' scores, and engineers' views — is 84%, bettered by only one of the 11 brands surveyed.

The latest issue of 'Which?' magazine reports: "Viessmann has been on the cusp of being a Best Buy boiler brand for the past few years, and 2017 sees it deservedly crack it. Its reliability score is the best of any brand. Two-thirds of owners would definitely recommend their Viessmann boiler to a friend. Engineers are positive about Viessmann too."

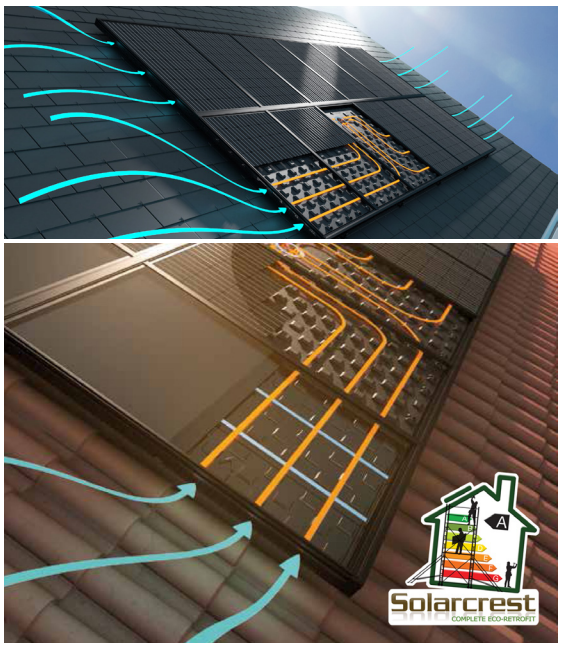
The survey found "there is a huge difference in reliability, customer satisfaction and what engineers make of the best and worst boiler brands." It concluded that buying a boiler on price alone is likely to be a false economy because customers could save £233 over six years by opting for the most reliable brand over the least.

The magazine advises: "The top three boiler brands in our survey do tend to cost a few hundred pounds more than the least reliable ones. We do think the extra cost is worth it though, particularly when you consider that the cost of a boiler tends to be only a small part of the overall installation cost."

Graham Russell, Viessmann managing director, commented: "We're proud to have received this recognition of our Vitodens boilers' high standards. Becoming one of only two gas boiler brands recommended by 'Which?' will go a long way towards engendering trust with consumers who may not yet be familiar with the Viessmann name. We hope this will also encourage more engineers who haven't yet worked with Viessmann's products to give them a try." ■



Solarcrest launches new 'aero-PV' technology for MVHR



(above) Solarcrest's new 'aero-PV' system uses solar energy to heat incoming fresh air.

Fabric-first ventilation and insulation specialist Solarcrest, who specialise in passive house certified MVHR systems combined with spray-applied expanding foam insulation, are now incorporating new award-winning solar technology from France into their ventilation offering.

MVHR units normally use a small electric heater to counteract the heat lost through ventilation, which is typically a degree or two per hour in mid-winter. This automatic duct heater ensures your fresh air supply is kept at, if not above room temperature, meaning zero heat loss — but naturally this also adds to your electricity bills.

However, to recover heat from the sun, Solarcrest's new 'aero-PV' roof panels connect directly to the MVHR air-intake, allowing the ventilation system to draw in warmed air instead of air at ambient outdoor temperature.

Solarcrest said that, according to test data, on an overcast day in freezing temperatures the system will still recover 1kW of thermal energy. To prevent overheating during the summer an innovative temperature sensing valve automatically switches the MVHR intake and exhaust, meaning you can draw in cooler air from a north elevation and exhaust the stale air on to the back of the solar panels. Switching the direction provides a modest level of comfort cooling to the home, as well as cooling the solar panels to improve their generation performance.

"It's a win-win. Free heating when you need it, free cooling when you don't. Electricity generation instead of electricity consumption," said Solarcrest director Eliot Warrington. The technology is currently pending passive house certification.

Meanwhile, Solarcrest has also announced it is in the process of converting its entire fleet to low emission vehicles. The company said that it is looking to significantly reduce its output of both carbon dioxide and other transport related pollutants and has started by changing pool cars, which are already lower-polluting LPG hybrids, to electric use. The company said it also plans to phase out all diesel usage in its other commercial vehicles when viable options are available to replace them. ■

MBC completes latest ultra low energy timber frame house

Passive house specialists MBC Timber Frame have recently completed construction of their latest timber frame house built with the company's passive wall and foundation systems. The project in Poole, Dorset was built for clients Margaret and Derek Jones, and features MBC's own 300mm Passive Wall twin-stud system, which is insulated with cellulose. The system delivers a U-value of 0.12, and is clad externally with Knauf Aquapanel.

The build also includes MBC's passive insulated raft foundation system, which features 300mm of EPS and has a U-value of 0.105, while the roof build-up delivers a similar U-value. The project also includes mechanical ventilation with heat recovery throughout the main house and the annexe, and features 44mm thick triple-glazed windows with an overall U-value of 0.8. The dwelling scored an airtightness test result of 1.9 air changes per hour, and a spokesperson for MBC explained to Passive House Plus that issues with the window installation prevented it from getting closer to the passive house standard of 0.6.

Veterans of several certified passive house builds, MBC opened a new factory in Gloucester last year, where all of its timber frames are now manufactured. For more information on the company's passive wall and foundation systems see **www.mbctimberframe.co.uk**. ■





(above) MBC's passive twin-stud build system and insulated foundations were used to build a new eco home in Poole, Dorset, for Margaret and Derek Jones.

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Smartply CPD to showcase airtight OSB for passive house design

(right) Medite Smartply's Propassiv airtight OSB board, applied to the inside of a roof construction.

Medite Smartply, manufacturers of innovative timber panels, has released its new RIBA CPD seminar titled: 'Specifying Airtight OSB for Passive House & Low Energy Buildings'. The new CPD demonstrates the "ground-breaking possibility" of achieving a vapour controlled airtight environment in timber frame buildings without the use of a plastic air and vapour control layer (AVCL) membrane, according to the company.

Smartply Propassiv is the first ever OSB to be classified airtight by the PHI," commented Stuart Devoil, head of marketing at Medite Smartply.

"Historically, AVCL membranes have been the material of choice. The problem being that AVCL membranes rely heavily on the material composition, the success of which depends on detailing, installation and workmanship on site. If an AVCL is snagged or torn it jeopardises airtightness. Smartply Propassiv can remove these variables by providing air and vapour tightness integral to a structural panel that is pre-cut and CE marked ready for installation on site."

The CPD has five clear learning objectives: defining the standards required for passive house and low energy construction, how to achieve airtightness in construction, which airtight products to use, a detailed explanation of Smartply Propassiv, and how to control vapour in timber frame buildings. To book the seminar, visit the Smartply Propassiv page on the RIBA CPD website at tinyurl.com/smartplycpd.



New website

Meanwhile Medite Smartply has also announced the launch of its new website, the latest stage in the company's rebrand project. Designed to provide a "customer-centric user experience", the website offers a comprehensive and detailed breakdown of the brand's entire range of MDF and OSB products, plus all supporting environmental and test certification. Visit the new site at **www.mdfosb.com**. ■

Green Building Store radical retrofit wins eco award

Green Building Store picked up a 'Vision & Sustainability' award at Leeds Beckett University's Rise (research, innovation, sustainability, enterprise) awards on 14 September.

The award was for Green Building Store's Lower Royd radical whole-house retrofit project. The Lower Royd project has involved the radical refurbishment of a Yorkshire farmhouse and barn using innovative internal wall insulation (IWI) techniques.

The project was designed using the Passive House Planning Package (PHPP), and has built on and developed Green Building Store's previous work on deep retrofit with challenging solid wall constructions.

Green Building Store said that the Lower Royd radical retrofit represents a development in its understanding of the whole-house radical retrofit approach, and in developing approaches to minimising moisture risk when using IWI.

The project is helping to inform other radical retrofits, and is the subject of ongoing academic research.

You can read blog posts on the Lower Royd radical retrofit project in the free resources section at **www.greenbuildingstore.co.uk**. ■



The Lower Royd farmhouse was internally insulated as part of a radical whole-house retrofit.



Choose HRV that works efficiently when it's freezing — Fresh-r

Fresh-r is a decentralised, standalone heat recovery ventilation system that removes stale air from a room and uses its patented copper wire heat exchanger to pre-heat incoming fresh air. Unlike centralised MVHR systems, there is no ducting, making it particularly suited for retrofit.

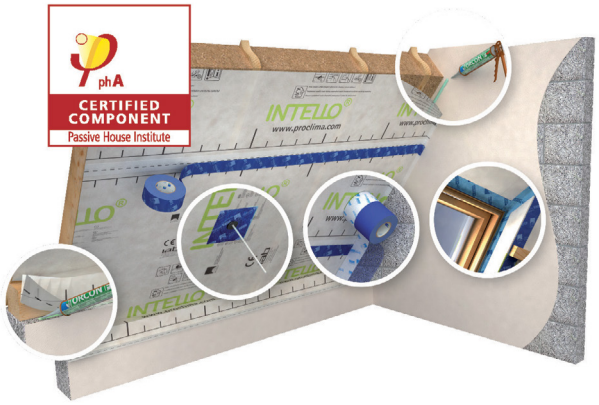
"Fresh-r is the only heat exchanger that works when it's freezing outside," the company's Edward Hissink told Passive House Plus. "All other heat exchangers tend to freeze up, and have to add a considerable amount of energy, because they have to heat up incoming fresh air by adding external energy."

Each Fresh-r unit contains 8km of fine copper wire as part of its patented heat exchanger. According to the company, copper has a heat transfer co-efficient of 400 W/m²K, making it "1000 times more efficient" than the polyethylene from which traditional heat exchangers are made. Fresh-r can boost incoming air at -5C up to 17.5C, if the internal temperature is 20C, making for an 87% efficiency.

The system, which is certified by the Passive House Institute, picked up a special 'component award' at last year's International Passive House Conference for ventilation in retrofit projects, with the judges impressed by its combination of energy efficiency and economic value.

Working by demand control, the system increases ventilation in response to rising CO_2 and humidity levels in a room. It is also designed to be particularly quick and easy to install, and can be wall-papered over too, for an unobtrusive appearance. ■

(above) The room-facing side of the Fresh-r decentralised heat recovery ventilation system.



Intello achieves best ever airtightness rating from Passive House Institute

The Pro Clima Intello intelligent airtightness system has been approved by the Passive House Institute as a certified passive house component, distributor Ecological Building Systems has confirmed. The certification includes the company's Pro Clima solid acrylic tapes Tescon Vana and Contega Solido SL.

"In comparison to other passive house certified membranes, test results on Intello and Pro Clima tapes confirmed the best airtightness results ever recorded by the Passive House Institute," said Ecological Building Systems technical engineer Niall Crosson. "This confirms the exceptional reliability and performance of Pro Clima solid acrylic glues and membranes."

Pro Clima have pioneered intelligent membranes for decades now in Ireland, the UK and all over the world.

The durability of Intello has been confirmed after decades of use and by national technical approvals including BBA and NSAI certification. The durability of Intello's humidity-variable properties has also been confirmed for at least 50 years by the renowned DIBt in Germany. All tests for this technical approval were carried out independently by an accredited testing institute. DIBt regularly monitors production, product quality and the durability of Intello.

"With its perfectly balanced variable diffusion profile, Intello ensures optimum protection against structural damage and mould all year round," said Crosson. "In winter, Intello has a very high diffusion resistance and provides optimal protection against structural damage and mould for building elements.

Even during the winter season when atmospheric and site humidity levels may exceed 90% for prolonged periods, Intello still provides outstanding protection. "In this way Intello is hydro-safe" said Crosson.

The hydro-safe value specifies how vapour resistant a humidity-variable vapour check is, even when exposed to very damp conditions often experienced on site in Ireland and the UK.

In summer, Intello can become extremely permeable if required. In this way, moisture which may have entered into a building component in an unforeseen manner can dry out. "This principle has proven itself in practice over more than 20 years and for many millions of square metres of installed Intello," said Crosson.

In contrast to membranes which feature a direction-dependent diffusion resistance, Intello cannot be accidentally installed the wrong way around. Crosson said Intello offers excellent protection against structural damage in both directions during the construction phase and also for the whole service life of the building – meaning Intello has the ideal intelligent vapour control properties for damp Irish and British building sites.

Intello is the only humidity-variable airtight membrane which has been approved by the German Institute for Civil Engineering (DIBt) with consistent third-party monitoring.

An independent test by the University of Kassel demonstrated the adhesive performance of Tescon Vana tape for a period of at least 100 years. Crosson said the waterproof solid-acrylate adhesive ensures reliable adhesion both indoors and outdoors, "even on wet surfaces – a crucial property in our damp Irish and British climates. This combined with Pro Clima's unique 10-year warranty means specifiers and homeowners have every confidence in Pro Clima intelligent airtightness systems."

For more information visit **www.ecologicalbuildingsystems.com.** ■

Systemair launches new intelligent controls for MVHR



Systemair has announced that launch of new intelligent control systems for their SAVE range of high efficiency mechanical ventilation with heat recovery (MVHR) units.

SAVECair is the new control system that "makes it simple and easy to control your indoor air with only a few touches," the company said.

The new controls are included in all SAVE MVHR units as standard and can be mounted on the wall in a hallway or kitchen if needed. The control panel has a user friendly, easy to use interface. All functions can be seen on the control panel's main screen and changed easily when required.

The new system allows users to optimise room air quality through intelligent controls; reduce energy consumption with eco-mode; use predefined user modes for optimum operating point; communicate using a modern touch display in colour; and connect to a unit via internet. Users can also access the system from anywhere through their smartphone by adding the internet access module (IAM). ■

(left) The new SAVECair intelligent control system.

Paint-on airtightness layer can revolutionise retrofit - Ecomerchant

An innovative paint-on airtightness product has the potential to revolutionise deep retrofit, leading sustainable building product distributor Ecomerchant has claimed.

The BBA certified Blowerproof system, can be spray-, roller- or brush-applied to deliver high levels of airtightness in a breadth of different locations in new build and retrofit projects – including one potentially transformative application behind external insulation layers.

Belgian manufacturer Hevadex has applied Blowerproof to deliver guaranteed passive house levels of airtightness on a wide range of projects of varying scales.

As part of the EU funded Schools of Tomorrow programme, Blowerproof was used externally to a Belgian school's masonry walls, before the external insulation layer was added – meaning, crucially, it remained on the warm side of the insulation layer, while hard-to-tackle junctions at party walls and intermediate floors were bypassed. This enabled the designers to leave the masonry exposed internally to slowly radiate heat into the room.

"Blowerproof is nothing short of airproofing magic," said Ecomerchant director Will Kirkman. "You simply paint it on, whatever your substrate - plaster, steel, masonry, render, cement, wood, mineral wool, humid surfaces, cables, pipes – and it creates an uninterrupted membrane which resists puncture."

Blowerproof paints on blue and dries jet black, which Kirkman points out helps to see that a permanent seal has been achieved. There is a white version too that can be used under plaster.

"It's a viscous liquid so it seals every nook and cranny no matter how tricky the shape of the gap or hole. You can then plaster, paint or do whatever else you need to over it," he said.

Kirkman added that brushes used with Blowerproof – which is VOC-free – rinse out with water. "And it costs £50 a tub so it quickly justifies both its product and labour costs." ■



(above) Blowerproof being spray-applied to the outer face of blockwork prior to an external insulation layer being installed.



Kingspan launches shallow-dig rainwater harvesting system

(above) An illustration of the Kingspan Gamma shallow-dig rainwater harvesting system.

Kingspan has launched a new premium 'shallow-dig' domestic rainwater system, which joins the company's well-established portfolio of rainwater-recycling solutions.

The company is offering the Gamma Rainwater range as a low-cost installation for self-build projects and residential developments, with a profile that requires a shallower dig and less excavation than traditional rainwater harvesting systems as well as less backfill to secure it in place. It's also ideally suited to rocky strata conditions where deep digs are not possible.

Gamma has been designed as a 'fit-and-forget' system, intended to provide homeowners with a seamless, automatic supply of harvested rainwater. It works by channeling rain from roof gutters, filtering out leaves and debris and then storing the water in an underground tank. This water is then conveyed to appliances (WCs, washing machines, outdoor taps etc.) either directly, via a header tank, or is pumped straight from the main storage tank where a tank is impractical. Systems which supply WCs or washing machines are automatically backed up with mains water at no inconvenience to the householder.

Kingspan Water Management's GB and Ireland commercial director Dave Vincent said: "Rainwater harvesting has been gradually growing in popularity during the past 10 years or so. However, it has long been popular abroad. For example, rainwater harvesting has been around for more than 20 years in Germany, which does not have as much rainfall as the UK [and Ireland] and is more reliant on groundwater."

According to Vincent, recent water usage restrictions introduced in UK building regulations have changed the landscape. "Limiting water usage is now a legal requirement in the UK for new build domestic properties; Building Regulations require that water consumption is limited to 125 litres per person, per day," he said.

"A rainwater harvesting system can halve the amount of water used by a homeowner and, unlike other water saving appliances (such as aerated taps) which can be upgraded or removed, rainwater harvesting systems will remain a constant feature of any development, ensuring targets for water management continue to be met for years to come."

Manufactured from tough polyethylene, Gamma's underground tank is robust and lightweight, making it easy to handle and install. Tank sizes range from 2,350 to 4,600 litres.

Gamma is fully compliant with all regulations and standards, having been tested in accordance with EN 12566 Part 1 and BS 8515:2009. ■

Smet picks up small business award

Smet Building Products, which supplies a wide range of products for low energy and fabric-first construction, picked up the award for best small business at the Greater Newry Business Awards, organised by Newry Chamber of Commerce & Trade, on 28 September at the town's Canal Hotel.

The award was presented by Patrick Anderson, chief financial officer of Translink, which sponsored the category. "We are over the moon," said Joris Smet of Smet Building Products. "There were over 500 local business representatives in attendance in the Canal Hotel and the super organisation of CEO Mary Meehan and her team meant the night was flawless."

Smet's range of products includes external wall insulation systems, floor screeds, plasters, renders and more. ■



(l-r) Patrick Anderson, CFO Translink; Joris Smet, managing director Smet Building Products; Deborah Smet, marketing manager, and Dr Colette Hood, operations manager.



PH+ **HELP DESK**

FIRE COMPARTMENTATION

& timber framed party walls

In his latest column, architect and DIT lecturer Simon McGuinness says that careful planning and attention to detail is essential for timber frame party walls to properly prevent the spread of fire.

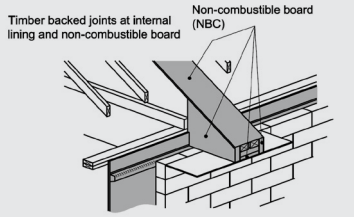


Figure 25 — Eaves box

Extract from Irish Standard 440:2009 Image reproduced with permission of NSAI

In this Help Desk I will be returning to the issue of compartmentation at party (separating) walls in residential construction. This time, on the request of several readers, I will look at timber framed party wall construction, which presents unique challenges.

The underlying principal of timber framed party wall (or "separating" wall) construction is that two entirely separate walls are required with an air gap between them. Each individual leaf is designed to contain the fire within its own compartment for a period of at least 60 minutes. Once the fire-resistant wall facing is breached by the fire, the exposed timber framing behind burns rapidly. Sixty minutes is assumed to be sufficient time to evacuate the compartment which is on fire and for the emergency services to contain the blaze. Most of these separating wall structures are designed to meet the performance required without additional margin. When there is no margin for error, particular attention is warranted to ensure the performance required is achieved.

In this form of construction, heavy reliance is placed on a near continuous fire resistant plasterboard facing to each leaf of the party wall. This facing is made up of two boards, typically a 19mm board tight against the stud and a 12mm board facing the room. Care must be taken to ensure that the joints between boards are overlapped in both directions by at least 600mm to avoid concurrent joints allowing fire to breach the facing. All plasterboard edges in this wall must be fully supported by vertical or horizontal framing (studs or noggins) to prevent delamination of the plasterboard layers under fire conditions. Joints must usually be taped and filled, even in the attic area, in order to achieve the tested fire performance of the double board lining.

The party wall is often a loadbearing structural element which means that floor joists penetrate the facing to rest on the timber frame behind. This introduces a weakness which requires additional measures to prevent smoke and flames entering the cavity between the two leaves. Similarly, it may be constructed in above-ceiling and below-ceiling sections requiring jointing details which also need particular fire-stopping. In this article, I will concentrate on the roof-to-wall junction as this continues to be problematic, mainly due to the complex coordination of responsibilities involved. If prompted by readers, I will deal with the other abutments of the party wall in future articles.

The assumption that the fire test of the linings is sufficient to determine the compartmentation standard of the wall rests on the faulty presumption that the plasterboard facings are continuous and extend up to the underside of the roof tile or slate without any gaps. They don't: the wall stops below the sarking layer which leaves a gap above it. Rafter alignment may introduce another gap below the sarking also. Those two gaps must be closed with mineral wool. To support the mineral wool, it is first necessary to install a non-combustible cavity closer board joining the top of the two leaves of the party wall.

Filling the residual gap between the non-combustible closer board and the underside of the roof tile/slate is a two-stage process, each stage of which may fall to a different contractor. The lower layer must be in place before the sarking is installed, whilst the upper layer is installed as part of the roof tiling/slating process. This creates a coordination problem: each of the mineral wool layers will be installed by different subcontractors, often weeks apart.

The resulting mineral wool 'sandwich' will close the gap between the top of the party wall and the underside of the roof tiles/slates. This 'sandwich' should be a little wider than the party wall it sits on and extend over the ridge from back of fascia on both sides of the roof. It also performs the very important function of measurably reducing the thermal bridge at the top of the party wall.

There is yet a further complexity relating to the eaves condition: closing off the overhanging eaves cavity. An extension of the party wall, called the "eaves box", is recommended for this in Irish Standard I.S. 440: 2009, 'Timber frame construction, dwellings and other buildings'. This eaves box is the same width as the party wall and completely fills the space between the fascia, soffit, external wall and the roof covering, see Figure 25 reproduced below. This is a time-consuming piece of bespoke carpentry to construct on site, which needs to be free of any gap which might permit the passage of smoke.

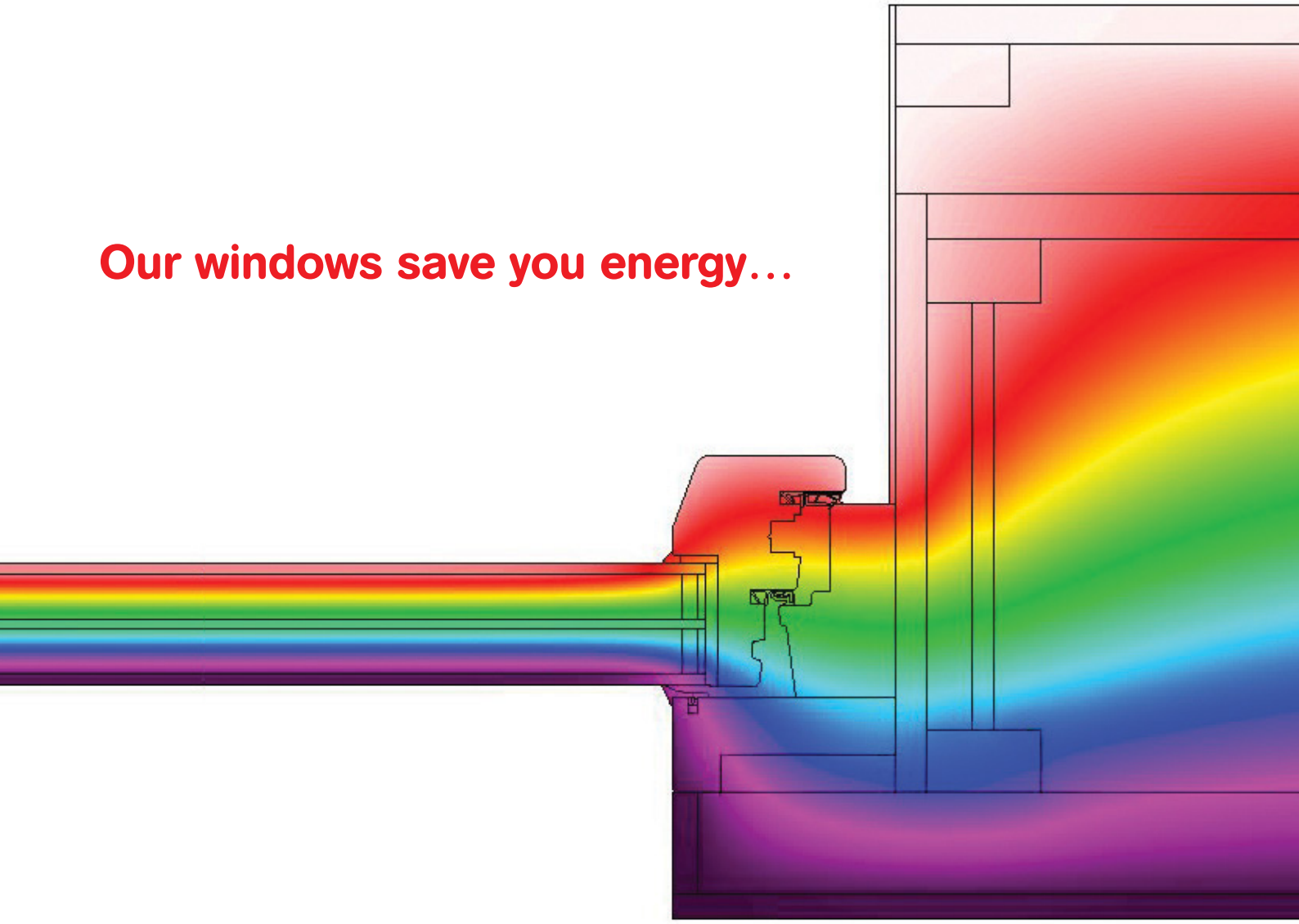
Table 1 summarises the nine sequential steps involved in adequately firestopping a timber framed party wall at roof level. This may involve supervising the work of seven different people. Its importance, and the management challenge it presents to specifiers, contractors and certifiers, should not be underestimated. ■

	Component	Responsibility	Trade
1	Timber frame	Timber frame S/C	Carpenter/joiner
2	Cavity closer board	Main contractor	Carpenter/joiner
3	Under-sarking MW	Main contractor	General operative
4	Sarking layer	Main contractor	General operative
5	External leaf	Brickwork S/C	Bricklayer
6	Eaves box	Main contractor	Carpenter/joiner
7	Slating battens	Roofing S/C	Slater/tiler
8	Over-sarking MW	Main contractor	General operative
9	Tiling/slating	Roofing S/C	Slater/tiler

TABLE 1: Nine-step sequence for fire stopping a timber frame party wall at roof level

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